RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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Henry Ford Hospital, Detroit 2, Mich.

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RADIOLOGY

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Pancreatography

Technics, Principles, and Observations[1]

HENRY DOUBILET, M.D., M. H. POPPEL, M.D., and JOHN H. MULHOLLAND, M.D.

WHEN THE SPHINCTER of Oddi is sectioned transduodenally, a plastic tube can be inserted into the main pancreatic duct. Through this tube pancreatic juice can be collected and a radiopaque solution can be injected for visualization of the pancreatic duct system.

The first attempt to obtain a pancreatogram was made on Feb. 4, 1947. Curiously enough, in this case the whole pancreas, as well as the duct system, was opacified (Fig. 1). Later it was found that such opacification of the tissues occurs only in the presence of acute inflammation. In the absence of inflammation the ducts alone are visualized (Fig. 2). Since the pancreatic duct is often dilated in cases of long-standing pancreatitis (Figs. 3 and 4),

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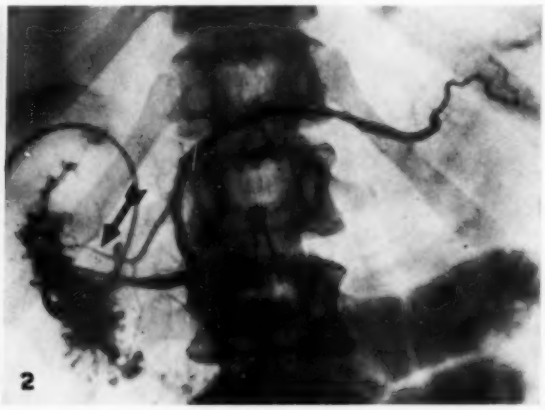

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Fig. 1. First operative pancreatogram obtained by injecting Diodrast through a plastic tube (arrow) inserted into the duct of Wirsung. Both the duct system and the acinar tissue were opacified due to the presence of acute inflammation throughout the pancreas.

Fig. 2. In the absence of acute inflammation, the pancreatogram delineates only the duct system of the pancreas. The plastic tube passes through the stump of the cystic duct, down the choledochus, makes a loop in the duodenum, and passes up the duct of Wirsung for a distance of 4 to 5 cm. Note the accessory duct of Santorini (arrow).

[1] From the Departments of Surgery and Radiology, New York University College of Medicine, New York, N. Y. Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5–10, 1954.

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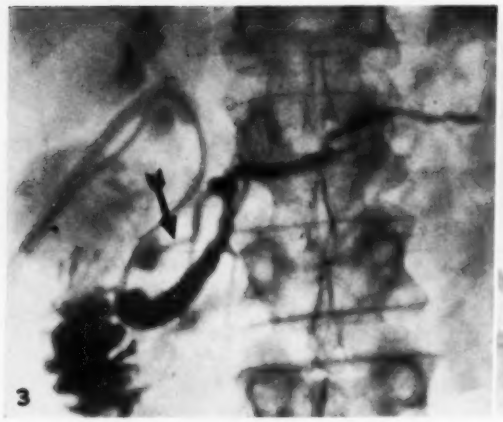


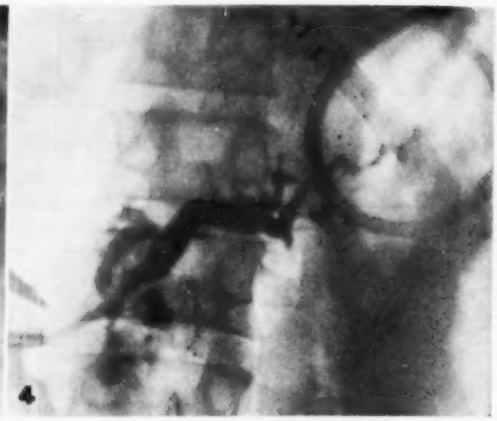


Fig. 3. Marked dilatation of the duct of Wirsung in a case of recurrent pancreatitis. The dilatation was due to long-standing spasm of the sphincter of Oddi, since the gallbladder was normal and no calculi were present in the biliary tract. Note the reflux of radiopaque solution back into the duodenum through the accessory duct (arrow).

Fig. 4. Pancreatogram in a case of advanced chronic pancreatitis. Note the marked dilatation of the ducts in the head and body of the pancreas.

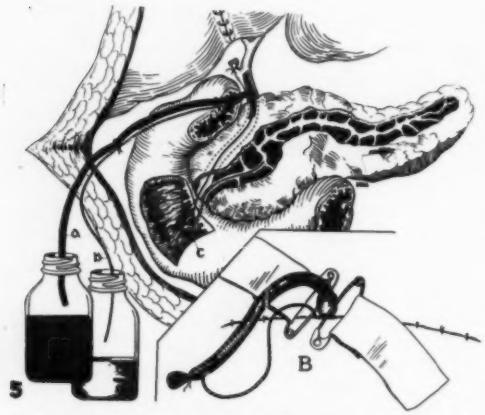


Fig. 5. The polyvinyl tube (*b*) passes alongside the T-tube (*a*), through the lower end of the T lying in the common duct, through the cut sphincter of Oddi (*c*), and up the pancreatic duct. Bile and pancreatic juice are collected separately. After four days the T-tube is tied and the polyvinyl tube inserted into it by means of a needle (inset B), allowing the pancreatic juice to circulate back into the duodenum.

it was thought that postoperative drainage of this duct would be of therapeutic value. Accordingly, a technic was developed (1) whereby a fine polyvinyl tube, about 50 cm. long and with an outside diameter of 1.3 to 1.7 mm., is inserted for a distance of 4 to 5 cm. up the duct of Wirsung and then brought out through the duodenum and choledochus alongside a T-tube (Fig. 5). In cases in which the common duct is not opened and no T-tube is used, the plastic tube is brought out through the cystic duct, to which it is fastened.

This produces a pancreatic fistula which can be controlled and maintained for weeks or months and closed at will by removing the tubes. Samples of pancreatic juice can be collected and serial pancreatographic studies can be made over a period of time. This procedure has been found to be safe and of diagnostic, therapeutic, and prognostic value.

Our observations cover 201 studies made on 100 patients. The technic developed and the physiological principles on which they are based may be summarized as follows:

1. At operation the pancreatic duct system can be visualized by the injection of 70 per cent Diodrast or 70 per cent Urokon through a plastic tube lying freely in the terminal part of the duct of Wirsung, which opens normally into the posterior wall of the ampulla of Vater. The radiopaque solution ascends and fills the duct system (Fig. 6) because, under conditions of starvation, the human pancreas secretes little or no juice. The injection must be made slowly, about 10 c.c. over a five-minute period, the last 2 c.c. being introduced during the x-ray exposure.

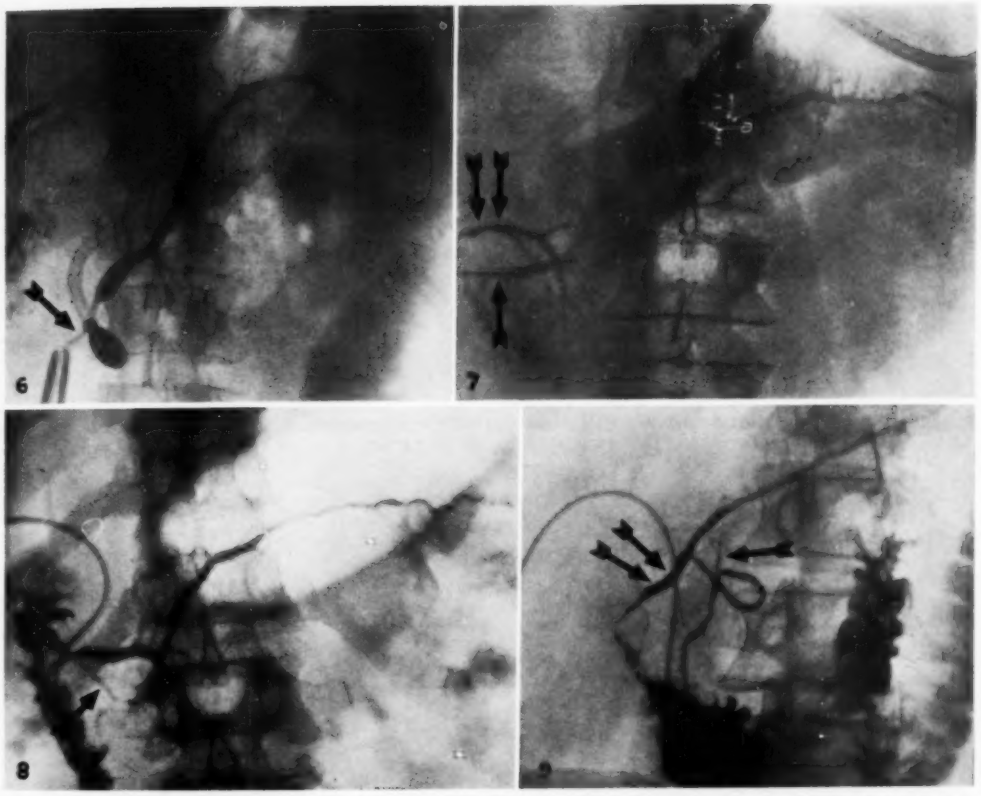


Fig. 6. Operative pancreatogram in a case of recurrent pancreatitis. Note the fine plastic tube being held by forceps in the orifice of the markedly dilated duct of Wirsung (arrow). The blob of density near the tail of the pancreas is due to a reflux of Diodrast back into the fundus of the stomach.

Fig. 7. Operative pancreatogram showing opacification of the ducts and visualization of the whole pancreas partly as a result of mild inflammation. A plastic tube lies in the duct of Wirsung (arrow). The accessory duct (2 arrows) and its connection to the main duct are shown clearly.

Fig. 8. Pancreatogram showing a complete circular loop in the middle of the duct of Wirsung. The accessory duct (arrow) arises from the base of the loop.

Fig. 9. Pancreatogram demonstrating the arrangement of the ducts during early embryological development. The duct of Wirsung (arrow) is the small one which ends abruptly without joining the duct of Santorini (2 arrows) except through a small lateral branch. The Diodrast was injected into the duct of Wirsung through the plastic tube lying in it.

The excess amount will flow out around the tube into the duct.

2. The accessory duct can be visualized frequently (Fig. 7), especially if the injection is continued during the period of exposure. In our series, the duct of Santorini could be seen emptying into the duodenum in 39 per cent of the cases studied. Occasionally, unusual anatomical relations of the ducts were demonstrated in the living patient (Figs. 8 and 9).

3. In addition to dilatation of the pancreatic duct system due to long-standing spasm of the sphincter of Oddi, the main pancreatic duct may be obstructed by a calcified area of inflammation (Figs. 10A and B) or by carcinoma (2) of the head of the pancreas (Fig. 11).

4. In the presence of acute inflammation of the pancreas, the acinar tissue is opacified as a result of changes in the permeability of the duct epithelium, allowing the opaque medium to permeate the part of the gland that is affected. This phenomenon cannot be attributed to rupture of the fine ducts. Experimental obstruction of the pancreatic duct causes a rapid rise of serum amylase and lipase, due to the pas-

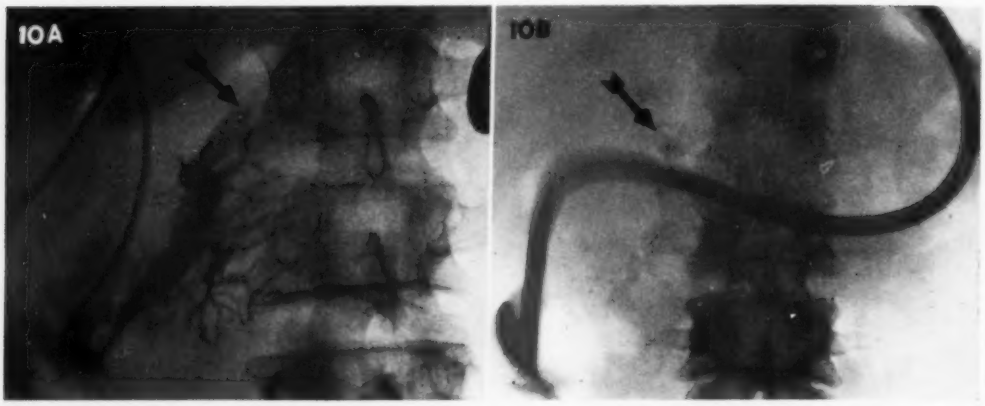


Fig. 10. Pancreatogram (A) in a case of long-standing chronic pancreatitis. Note the marked dilatation of the ducts in the head of the pancreas. Visualization of the main duct stops abruptly at an area of calcification (arrow) seen in a simple film of the abdomen (B) in this case.

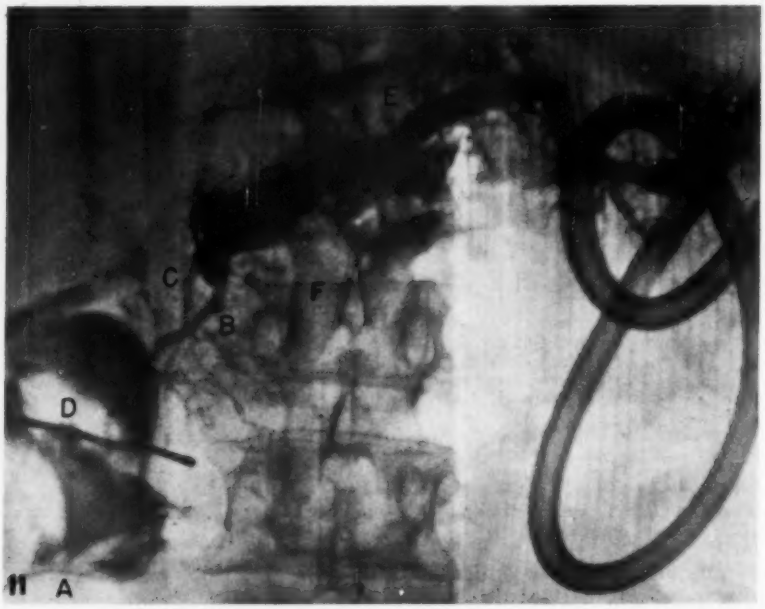
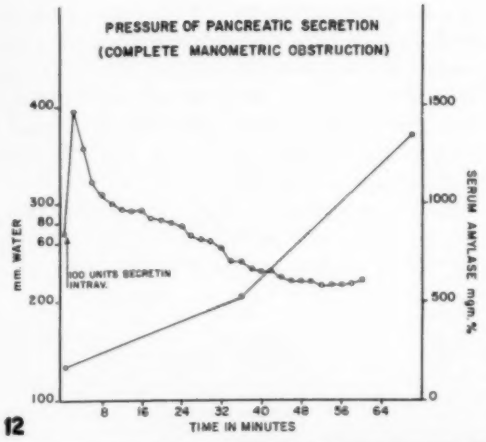


Fig. 11. Pancreatogram obtained through a plastic tube (A) reveals a normal pancreatic duct (B) which has been partially obstructed by carcinoma at its junction with the accessory pancreatic duct (C). Injection of Diodrast up the tube made it spurt out through the accessory duct into the duodenum. This was plugged by inserting a probe (D) into the accessory duct. The markedly dilated pancreatic duct (E) above the point of obstruction is clearly demonstrated. In addition, owing to probable ulceration of the cancer through its wall, the superior mesenteric vein (F) is partially visualized.

sage of the enzymes into the lymph and blood stream through the altered ducts. A significant experiment (Fig. 12), in which the intraductal pressure was never above physiological limits, demonstrates this principle. The extent and site of inflammation determine the area of opacification. At times the whole pancreas may be opacified (Fig. 13), at others only regions in the head, body, or tail (Figs. 14, 15, and 16). These findings have been correlated with observation and palpation



of the pancreas at operation and, as will be shown later, with loss of opacification upon resolution of inflammation. Thus, the principle is established that the radiopaque solution is contained in a normal duct system, but in the presence of acute inflammation permeates the acinar

Fig. 12. In a patient with a permanent pancreatic fistula, following traumatic rupture of the duct, the manometric pressure for a five-minute control period was found to be 270 mm. water. Following the injection of 100 units of Secretin (Lilly), the pressure rose in two minutes to 390 mm. With the flow of pancreatic juice completely obstructed by the manometric column, the secretory pressure fell to 220 mm. During this period the serum amylase (and lipase) rose rapidly, indicating increased permeability of the bile duct epithelium to the pancreatic juice.

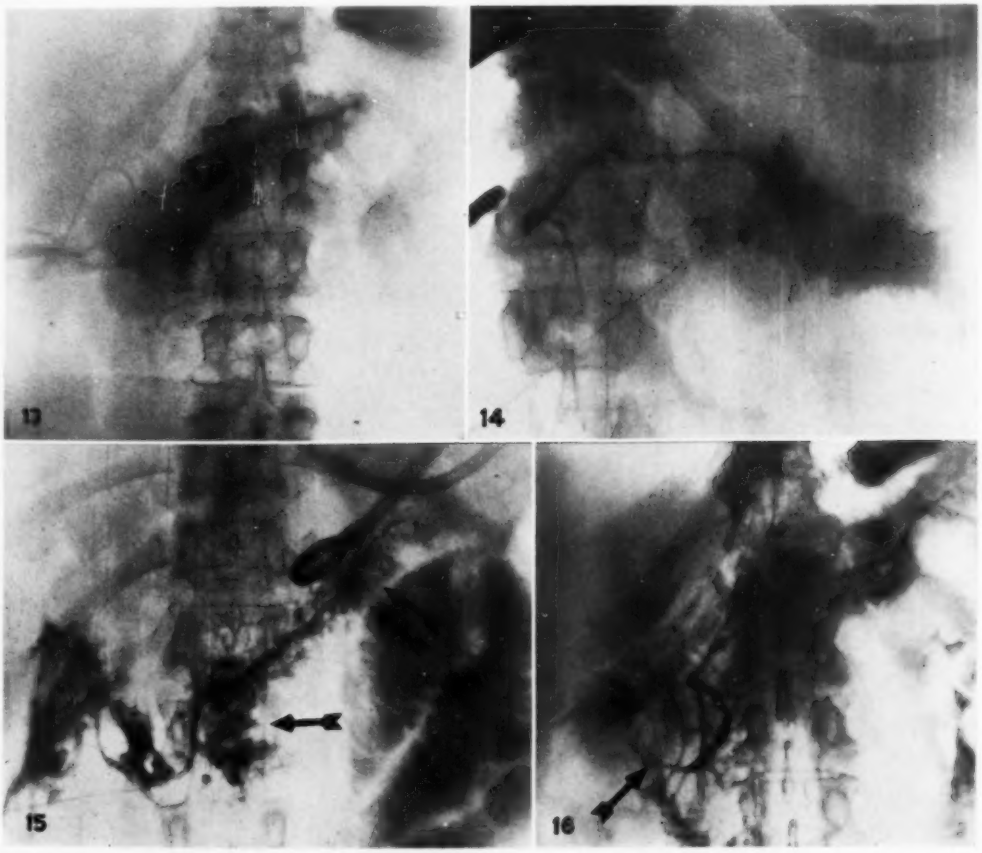
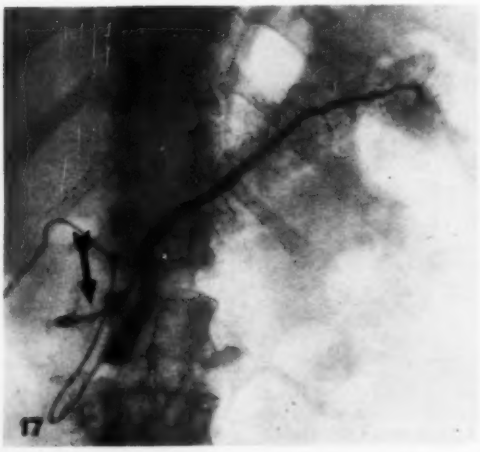


Fig. 13. Operative pancreatogram in which the whole pancreas was opacified. On palpation the pancreas was found to be acutely inflamed, hard, and edematous.

Fig. 14. Operative pancreatogram: opacification of tail of pancreas, due to localized acute inflammation.

Fig. 15. Operative pancreatogram in which the head (arrow) and part of the body (arrows) were opacified due to localized areas of acute inflammation.

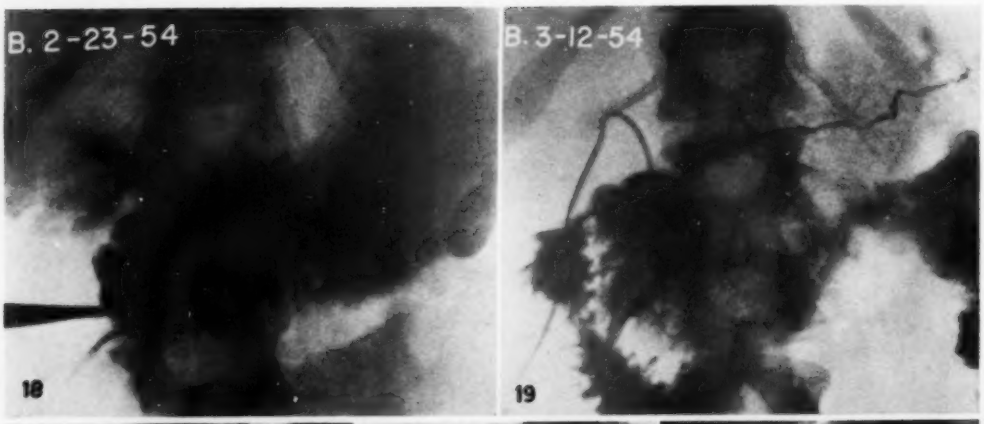
Fig. 16. Pancreatogram showing opacification of the body of the pancreas. Note accessory duct (arrow) crossing the plastic tube where it lies in the choledochus.

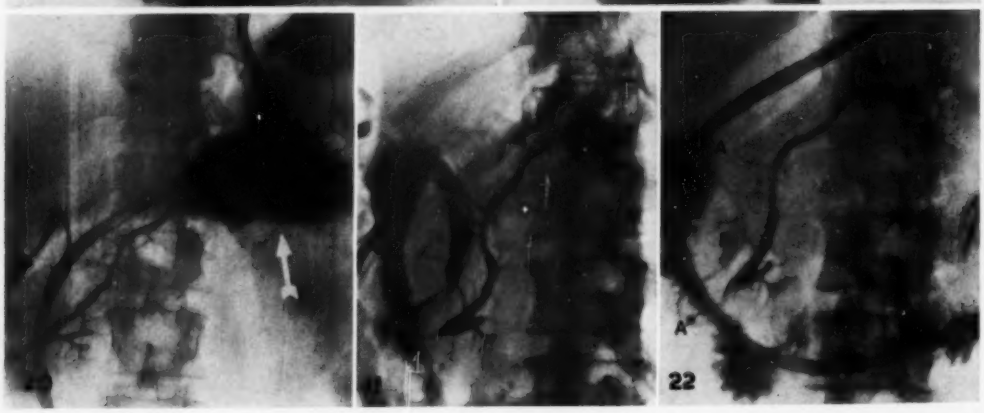


tissue and opacifies it. There is an intermediate stage of mild edema of the pancreas. In such cases the secretory pressure is diminished so that the radiopaque medium is pushed up into the finer pancreatic ducts but does not opacify the acinar tissue (Fig. 17).

5. Postoperative serial pancreatograms can be made at weekly intervals by injecting the radiopaque solution under the fol-

Fig. 17. Pancreatogram in a case of pancreatitis in which the acute inflammation has subsided but edema is still present to palpation. Note visualization of the fine ducts without opacification of the acinar tissue. The dilated main and accessory (arrow) ducts are typical of long-standing recurrent pancreatitis.





Figs. 18 and 19. Operative pancreatogram (Fig. 18) in a case in which the acute inflammation was still present. Pancreatographic studies seventeen days later failed to show opacification of the acinar tissue, indicating subsidence of the acute inflammation.

Figs. 20–22. The operative pancreatogram (Fig. 20) opacified the tail of the pancreas (arrow), which was found to be acutely inflamed on palpation. Serial pancreatograms at two-week intervals showed partial (Fig. 21) and then complete (Fig. 22) disappearance of the opacification. Note plastic tube lying in the choledochus and running up the pancreatic duct (A) and the accessory duct (B).

lowing conditions: (*a*) The patient should not have eaten since the previous night. (*b*) Probanthine (15 mg.) should be given intramuscularly one hour before the examination to reduce pancreatic secretion to a minimum and to lower the concentration of enzymes in the juice. This will tend to minimize the reaction of the pancreas to the irritant effect of the radiopaque solution. (*c*) The tonus of the duodenal wall should be increased strongly by the subcutaneous administration of morphine (15 mg.) five minutes before the examination. This will effectively compress the duodenal wall around the plastic tube lying loosely in the duct of Wirsung and result in complete filling of the pancreatic duct system.

6. The pathologic process in pancreatitis can be studied by the technic of intubation of the pancreatic duct, and principles established to serve as the basis for therapeutic procedures. The following observations have been made: (*a*) Opacification of the pancreas disappears as the acute

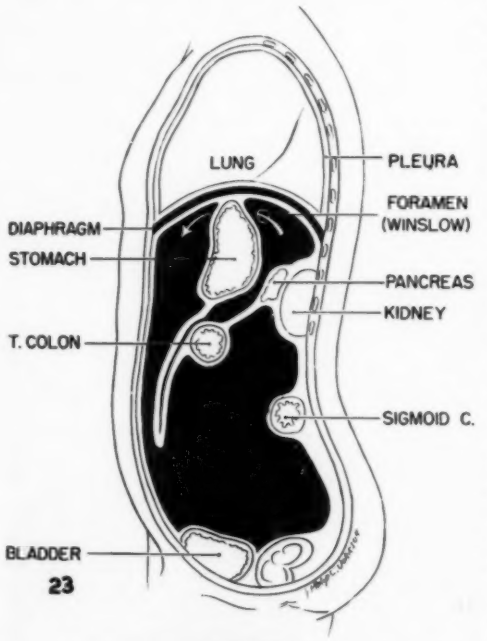
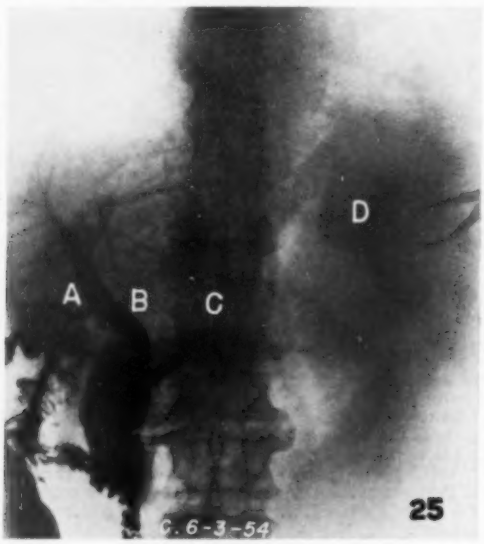
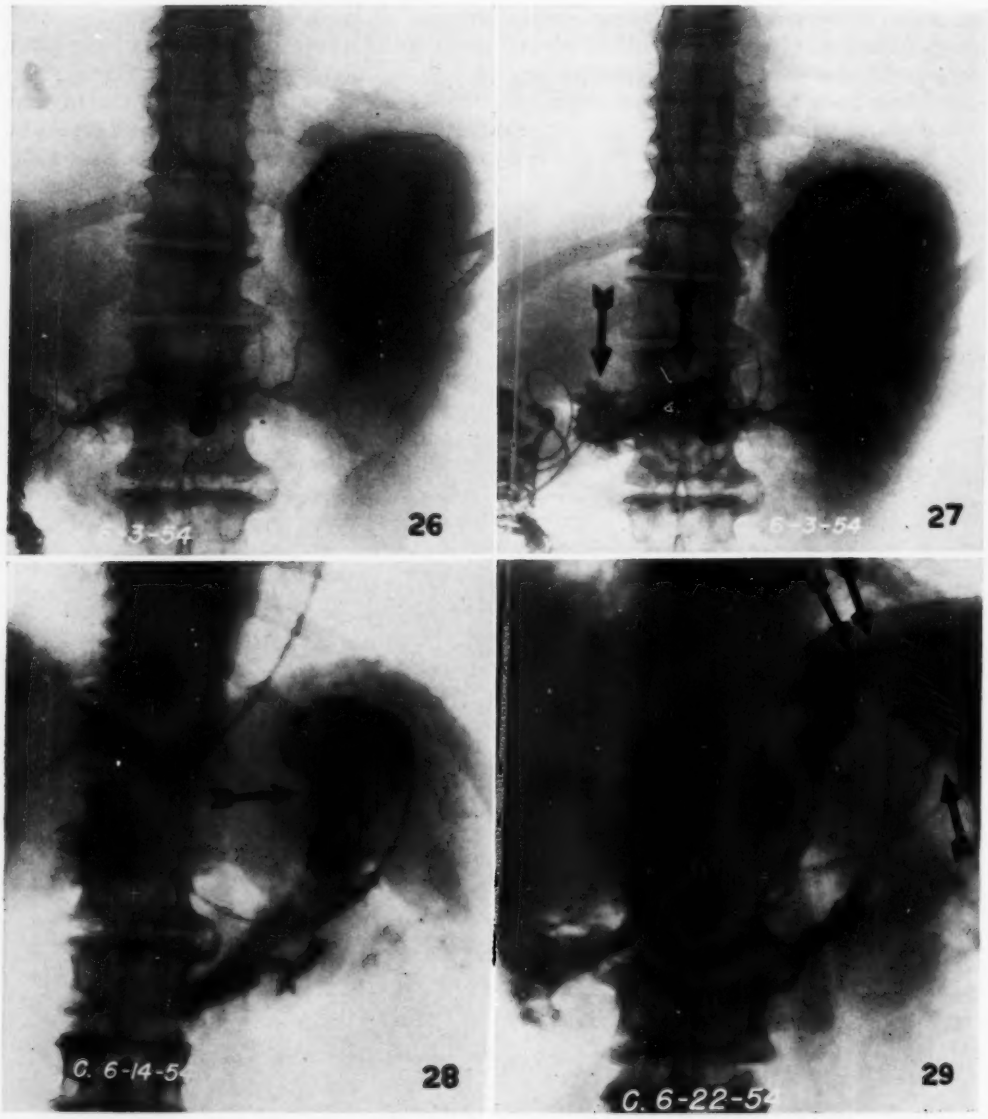


Fig. 23. Sagittal section through the left nipple line shows in a roughly diagrammatic manner the retroperitoneal space in which the pancreas lies. Exudate following acute inflammation will surround the capsule of the kidney and spread down as far as the sigmoid mesocolon. Upward spread will be contained by the diaphragm except at the hiatus through which the aorta passes. Here the exudate may invade the posterior mediastinum. The exudate may also spread anteriorly between the leaves of the mesocolon as well as the gastrocolic omentum.

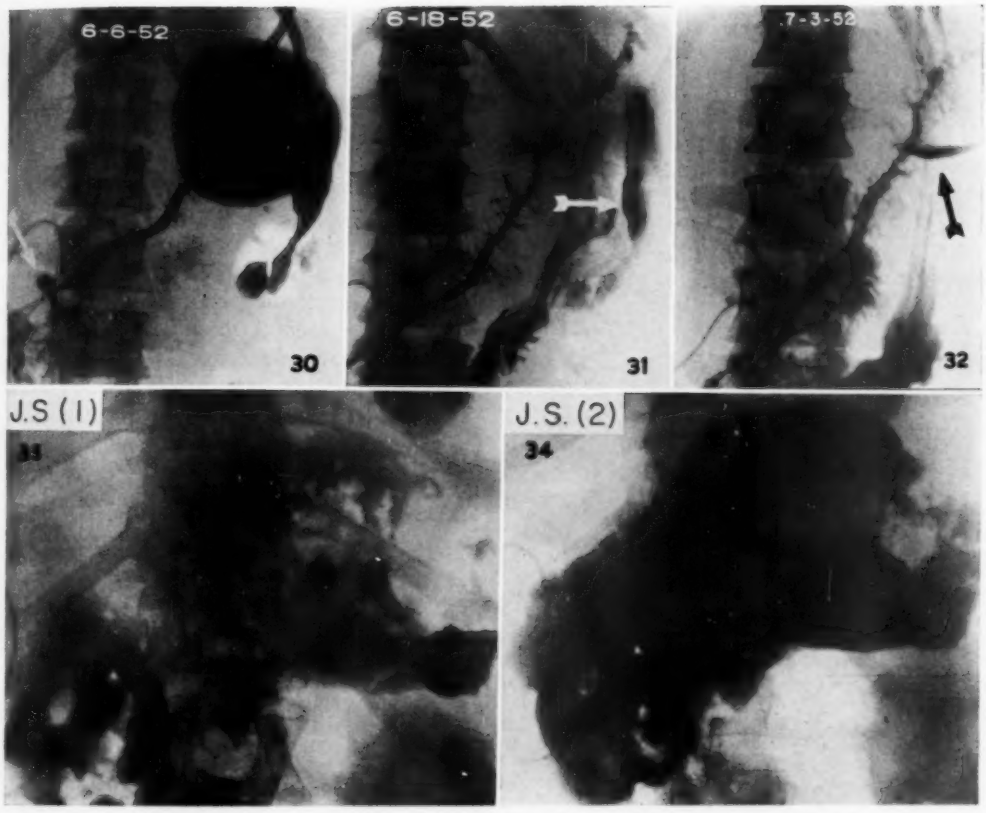


Figs. 24 and 25. Barium study showing a huge pseudocyst of the pancreas displacing the stomach upward and to the right (Fig. 24). At operation a cholangiogram showed Diodrast passing down the cystic duct (A) and choledochus (B), up the pancreatic duct (C), and beginning to fill the pseudocyst (D), previously emptied through a plastic tube inserted directly into it (Fig. 25). See also Figs. 26–29.



Figs. 26–29. Same case as Figs. 24 and 25. Diodrast injected through another plastic tube inserted into the pancreatic duct, after section of the sphincter of Oddi, visualized the sacculated and dilated pancreatic duct and continued to fill the pseudocyst (Fig. 26). Diodrast continued to be injected. An exposure (Fig. 27) a few minutes after the one in Fig. 26 showed complete filling of the pseudocyst. The acinar tissue of the head and body of the pancreas is now beginning to be opacified (arrows).

Serial studies of the pseudocyst through the retained plastic tube eleven days (Fig. 28) and nineteen days (Fig. 29) after operation, showed rapid subsidence of the size of the pseudocyst (arrow), because section of the sphincter of Oddi made it easier for the pancreatic juice to flow into the duodenum than up into the pseudocyst. In Fig. 29 Diodrast is seen to pass readily down the pancreatic duct into the duodenum, with reflux up into the stomach (2 arrows).



Figs. 30–32. Large pseudocyst of the pancreas extending down the left lumbar gutter retroperitoneally, treated by sphincterotomy and drainage of the duct of Wirsung by a plastic tube passing up the common duct and out through the stump of the cystic duct (Fig. 30). Note blind dilated end of the accessory duct (arrow). Twelve days after operation (Fig. 31) the pseudocyst was no longer visualized and the involved left lumbar space had shrunk markedly (arrow). A pancreatogram obtained twenty-seven days after operation (Fig. 32) showed only a small residual space (arrow). The patient was completely cured.

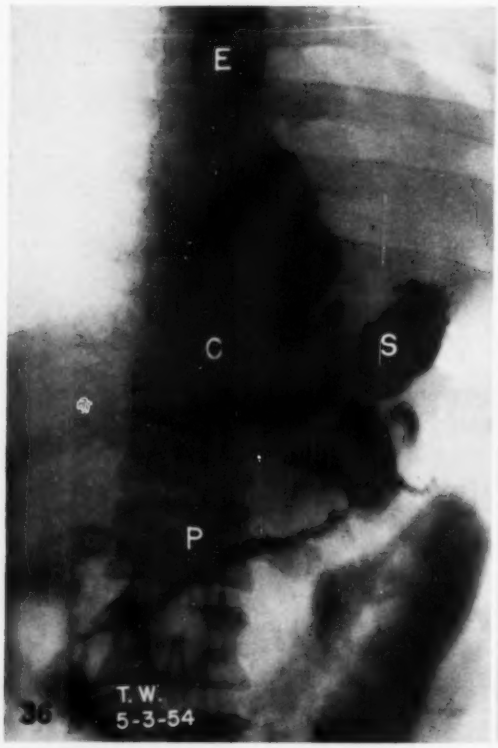
Figs. 33 and 34. Large pseudocyst of irregular shape and depth beneath the head and body of the pancreas, visualized by injection of Diodrast into the pancreatic duct after section of the sphincter of Oddi (Fig. 33). Further injection produced complete filling (Fig. 34), apparently because of a rupture in the main duct in the head of the pancreas. The pseudocyst was clearly visible as a thin-walled sac between the spine and the inflamed pancreas.

inflammation resolves. This can be demonstrated in a patient in whom the entire gland was acutely inflamed (Figs. 18 and 19) and in another patient in whom the inflammatory process was limited to the tail of the pancreas (Figs. 20–22). (*b*) The origin, spread, persistence, and treatment of pseudocysts can now be understood as a result of serial pancreatographic studies. The pancreas is a retroperitoneal organ (Fig. 23), and acute inflammation, when it occurs, will spread in various directions and form exudates. If, as a result of necrosis, one or more of the smaller pancreatic ducts is ruptured, pancreatic juice will accumulate retroperitoneally and form a collection which will increase in size if the intraductal tension is high as result of spasm of the sphincter of Oddi. The following case illustrates the etiology of acute pancreatitis due to reflux of bile into the pancreas, as well as the etiology of the resulting pseudocyst formation:

A patient on admission was found to have a huge pancreatic pseudocyst (Fig. 24). At operation this was aspirated and a fine plastic tube was inserted into it.

Diodrast was then injected into the cystic duct (Fig. 25) and was seen to pass down the common duct to the spastic sphincter of Oddi, and up the pancreatic duct, beginning to fill the cyst. The sphincter of Oddi was then cut transduodenally and a plastic tube was inserted. Through this tube the whole cyst was outlined by the radiopaque solution (Figs. 26 and 27). The operation was then completed, and the resolution of the cyst could be followed by serial injection of Diodrast (Figs. 28 and 29). The priuciple of treatment of pseudocysts by cutting the sphincter of Oddi can thus be established.

Fig. 35. Case T. W. Operative pancreatogram demonstrating a large pseudocyst of the pancreas lying in the posterior mediastinum (arrow). The connection to the pancreatic duct through the diaphragm was apparently by way of the retroperitoneal space around the aorta. Note opacification of the body of the pancreas (arrows).



Figs. 36 and 37. Case T. W. Simultaneous visualization of the pancreatic duct and pseudocyst by Diodrast injected into the plastic tube and of the esophagus and stomach by barium swallow, revealing the exact position of the pseudocyst in relation to the esophagus (E. Esophagus. S. Fundus of stomach. C. Pseudocyst. P. Pancreatic duct).

Another case (3) in which a very large pseudocyst extending down the left lumbar gutter was present was treated by similar methods (Figs. 30–32). In still another instance a pseudocyst was present beneath the head and body of the pancreas (Figs. 33 and 34). The final case, illustrating the pathological process and the treatment of pseudocysts, was unusual in that the pseudocyst was in the posterior mediastinum (Figs. 35–38). This case is unique also because the pancreatographic study was the only means for establishing the presence of the pseudocyst in the mediastinum. Without this procedure, the diagnosis could not have been established by roentgenographic means or by actual palpation at operation.

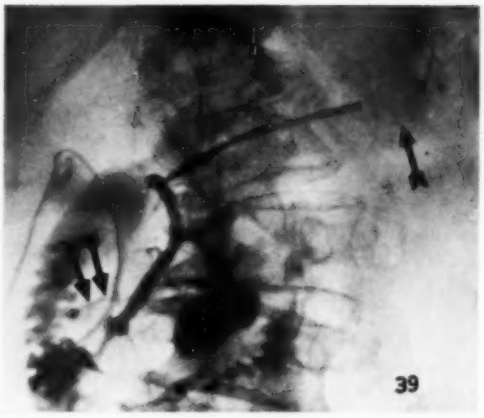
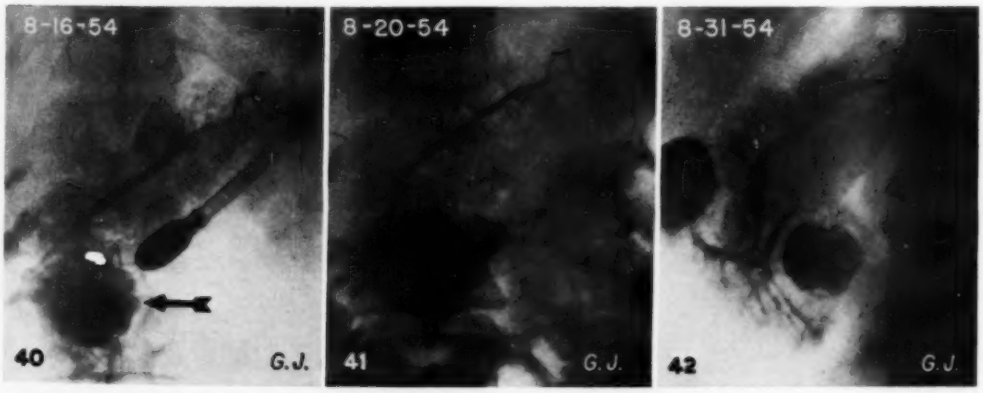


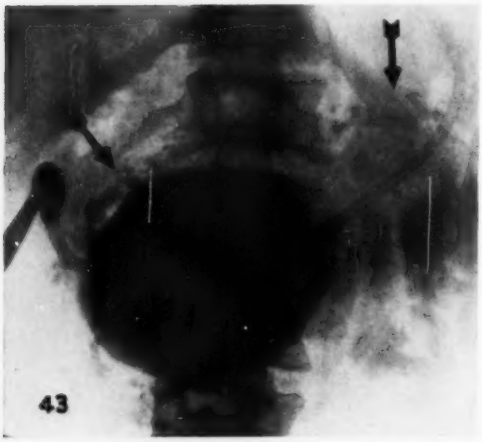
Fig. 39. Operative pancreatogram in a case where destruction of the pancreatic ducts in the left lumbar gutter (arrow) did not result in the formation of a pseudocyst. This was due probably to adequate treatment which prevented the accumulation of pancreatic juice. Note accessory duct (2 arrows) emptying into the duodenum.

Fig. 38. Case T. W. Pancreatogram taken thirty-one days after operation, during which time the pancreatic duct drainage was about half pancreatic juice and half greenish pus, showing that the pseudocyst had closed completely, only a fine space remaining (arrow). The patient was completely cured.

In some cases necrosis of the fine pancreatic ducts and inflammation of the retroperitoneal tissue in the left lumbar gutter will not lead to the formation of a pseudocyst, probably because adequate treatment prevents the accumulation of pancreatic juice by reducing the tone of the sphincter of Oddi and putting the pancreas at rest (Fig. 39).

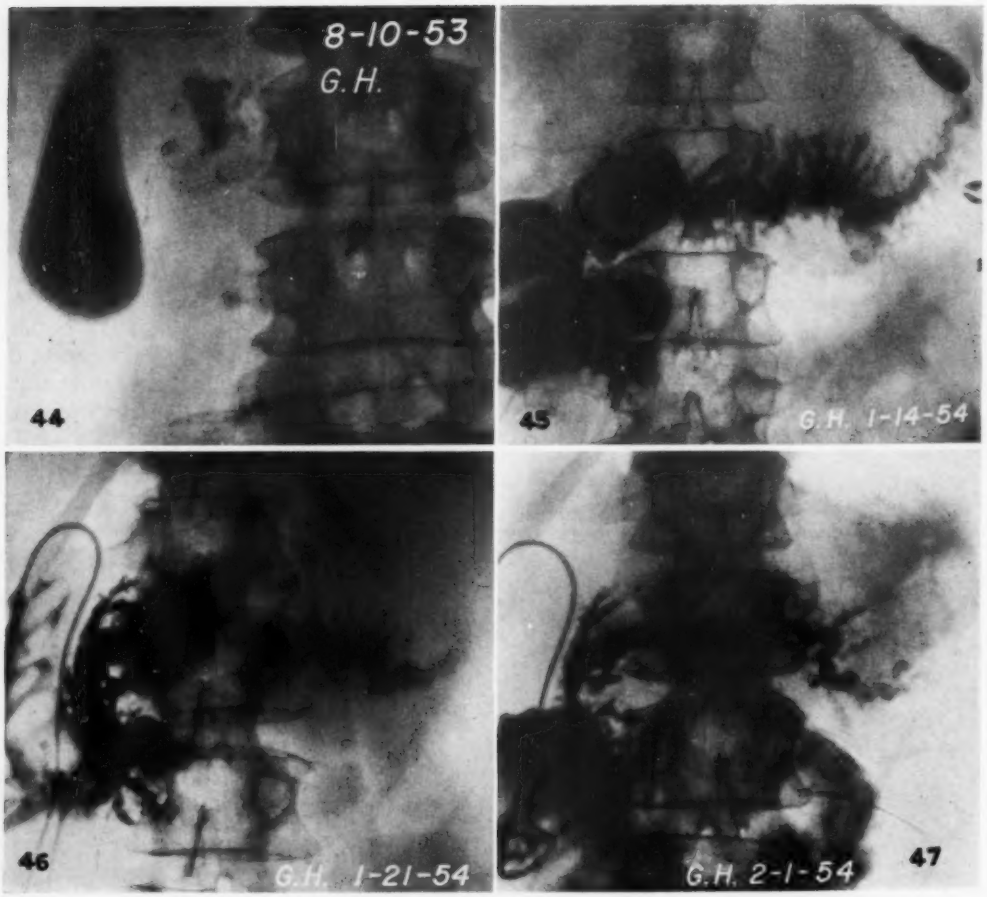


Figs. 40–42. Operative pancreatogram revealing early true cyst of the head of the pancreas (arrow) (Fig. 40). Continued drainage of the duct of Wirsung through a plastic tube after section of the sphincter of Oddi resulted in gradual diminution in size of cyst (Figs. 41 and 42).



True cysts of the pancreas are formed only in the head and are due to necrosis of the wall of the duct and surrounding acinar tissues. In early cases there is evidence of resolution after the sphincter is cut (Figs. 40–42). Later, however, such lesions may become isolated, form leathery walls, and have to be treated by anastomosis to the gastrointestinal tract (Fig. 43). At times calcium carbonate stones are precipitated in such a cyst and have

Fig. 43. Huge cyst of the head of the pancreas, opacified at operation by emptying contents and refilling with Diodrast. There was no connection to the pancreatic ducts. Note calcification of head and tail (arrows).

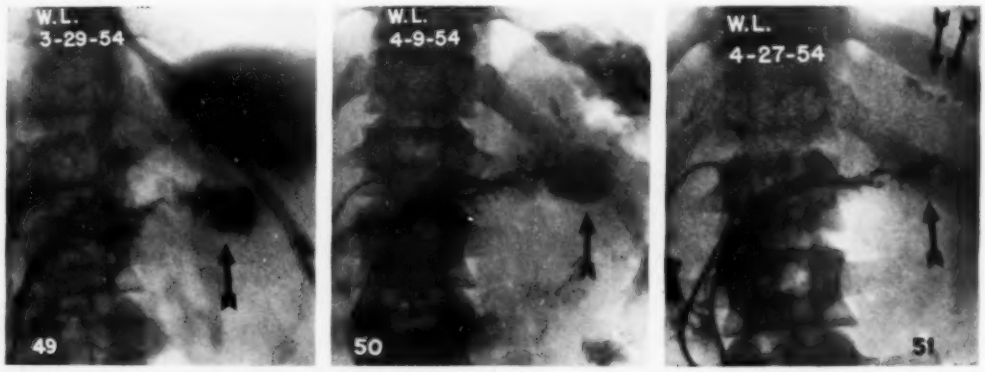


Figs. 44–47
(For legend see opposite page)

to be removed by incision of the head of the pancreas, which is subsequently sutured (Figs. 44–47). Following removal of the calculi and section of the sphincter of Oddi, the whole pancreatic duct can be seen to have regenerated and narrowed down markedly.

Although no true cysts arise in the tail of the pancreas, cystic dilatations, abscess formation, and enlargement of the whole tail may occur, as shown in Figure 48. This appearance on the pancreatograms was confirmed at autopsy in this case. In another instance serial pancreatographic studies showed gradual improvement in the chronic inflammatory condition in the tail of the pancreas (Figs. 49–51).

Fig. 48. Marked enlargement of the tail of the pancreas, with apparently cystic dilatations, shown in an operative pancreatogram. The tail was buried in a dense retroperitoneal mass. At autopsy, five days later, the tail was found to be transformed into a granulomatous mass of dilated ducts and multiple acute and chronic abscesses.



Figs. 49–51. Operative pancreatogram (Fig. 49) shows cystic dilatation of the tail of the pancreas. Continued drainage of the pancreatic duct through a tube showed marked improvement in the radiological appearance of the condition (Figs. 50 and 51). Dense irregular line (2 arrows) is area of calcification produced in a previous attack.

7. Deliberate opacification of the whole pancreas was achieved as a result of the following course of events. It was noted that, when acute inflammation of any part of the pancreas was present, the pancreatic juice flowing from the pancreatic tube contained active trypsin instead of inactive trypsinogen. When the acute inflammation subsided, as evidenced by the loss of opacification of the pancreatic tissue, the active trypsin disappeared (Fig. 52). It was also noticed that, when 70 per cent Diodrast was injected into the pancreatic duct, active trypsin appeared in the pancreatic juice within a few minutes and persisted for several hours. On this basis, it was postulated that the Diodrast produced an irritative inflammation of the

Figs. 44–47. Case G. H. Calcification of the head of the pancreas (Fig. 44) was found by operative pancreatography to be a markedly irregular calculus lying in a cyst of the head of the pancreas (Fig. 45) and partially obstructing an enormously distended duct behind it. The calculus was removed by an incision into the head of the pancreas. A plastic tube was used to drain the cavity through the duct of Wirsung.

Pancreatogram one week after operation showed an irregular space still present but the distal pancreatic duct reduced in caliber. Eleven days later (Fig. 47) the pancreatic duct can be seen to be re-formed.

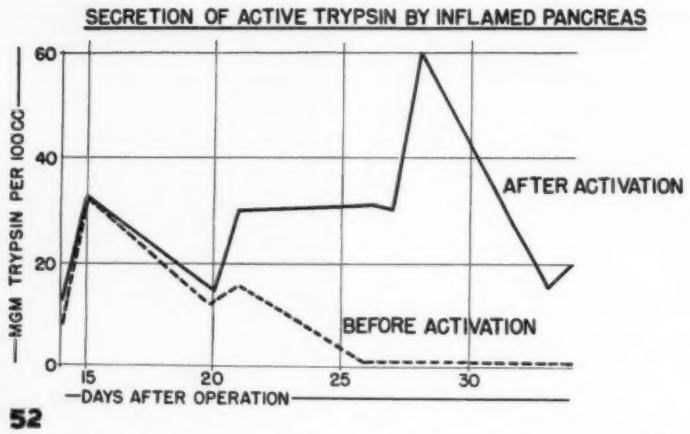
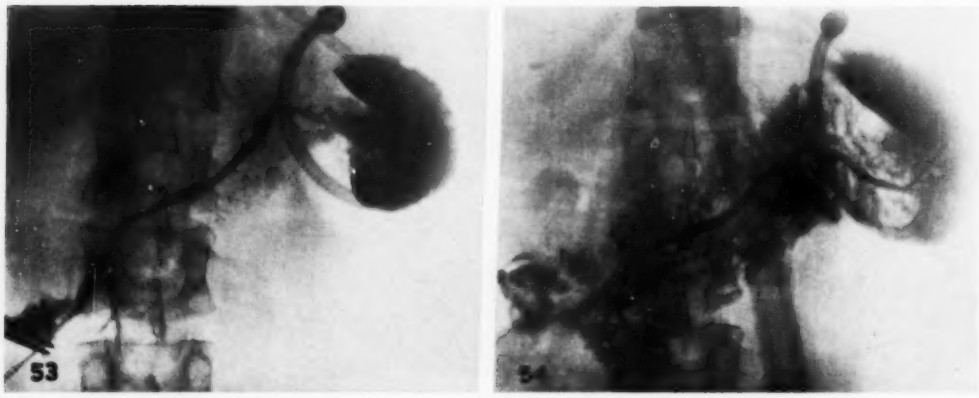


Fig. 52. Graph illustrating presence of active trypsin in pancreatic juice in a case of acute pancreatitis, and its gradual disappearance as acute inflammation subsided. Radiological evidence of the subsidence of the inflammation is presented in this case in Figs. 20–22.



Figs. 53 and 54. Operative pancreatogram revealing pancreatic duct (Fig. 53). After ten minutes the injection of more Diodrast opacified the acinar parenchyma (Fig. 54), due to increased permeability as a result of inflammatory reaction to the Diodrast.

pancreas. Therefore, if the pancreatographic study was repeated ten minutes later, it should visualize the entire pancreas. This was found to be so (Figs. 53 and 54). Since adenomas of the pancreas are not connected with the pancreatic duct system, such a procedure should show them up as negative shadows. This was attempted in a patient who was suffering from hyperinsulinism, but no adenoma was found by this technic (Fig. 55). Gross palpation of the pancreas also failed to reveal the presence of a tumor.

SUMMARY

A method for roentgenographic visualization of the pancreas is described. The procedure may be performed at operation or in the postoperative period. The method is safe and is of value in: (1) demonstrating the anatomy of the pancreatic duct system; (2) demonstrating etiological factors and various pathological features in the clinical course of recurrent pancreatitis; (3) demonstrating the presence of edema or acute inflammation in any part of the pancreas and its resolution

under treatment; (4) deliberately opacifying the exocrine pancreatic parenchyma in the non-inflamed pancreas, thus aiding in the search for smaller pancreatic masses such as adenomata.

These conclusions are based upon 201 studies made on 100 patients.

New York University-
Bellevue Medical Center
550 First Ave., New York 16, N. Y.

Fig. 55. Opacification of the whole pancreas obtained following injection of Diodrast ten minutes after a preliminary injection of Diodrast. This was a case of hyperinsulinism in which an attempt was made to find an adenoma.

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SUMARIO

Pancreatografía

Descríbense aquí técnicas destinadas a la visualización roentgenológica del páncreas y de sus conductos. Lógrase esa visualización con la inyección de una sustancia radiopaca contenida en un tubillo plástico que se introduce en el principal conducto pancreático. Se indican los variados hallazgos presentes en las afecciones del páncreas.

El procedimiento puede ser llevado a cabo al operar o durante el período postoperatorio. Es inocuo y de valor para: (1) mostrar la anatomía del sistema de los conductos pancreáticos; (2) descubrir los factories etiológicos y varias características histopatológicas en la evolución clínica de la pancreatitis recurrente; (3) descubrir la presencia de edema o inflamación aguda en cualquier parte del páncreas y la resolución de los mismos bajo tratamiento; (4) obtener deliberadamente opacificación del parénquima pancreático exocrino en el páncreas no inflamado, ayudando así en la pesquisa de pequeñas tumefacciones pancreáticas, tales como adenomas.

The Normal Interpediculate Space in the Spines of Infants and Children

WAYNE A. SIMRIL, M.D., and DONALD THURSTON, M.D.

AN ORIGINAL study by Elsberg and Dyke (3, 4) in 1934 pointed out the rarity of destructive bone changes in certain types of spinal cord tumors. Also noted was the need for other roentgen findings which might contribute to the diagnosis of spinal cord tumor without contrast studies, inasmuch as a thorough clinical and plain roentgenographic study should be undertaken before the final diagnostic step.

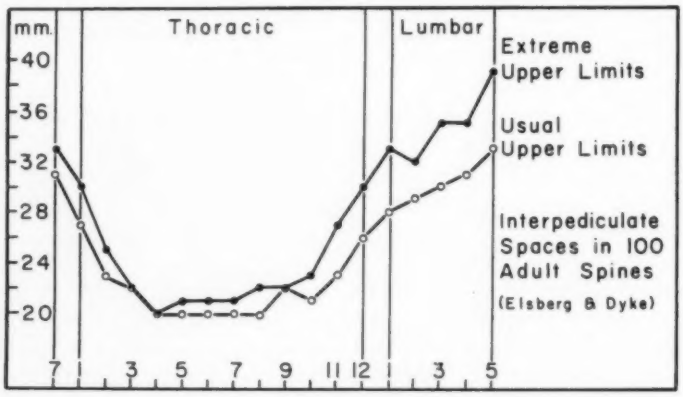

Fig. 1. Standard Elsberg and Dyke chart of usual and extreme normal adult interpediculate space measurements.

Accordingly, these two authors measured the interpediculate spaces in roentgenograms of 100 normal spines in subjects above the age of twelve years. Plotting the measurements on a graph, they obtained the interpediculate space curve (Fig. 1) which has since been widely used as a standard normal. The two curves on the graph indicate "usual" and "extreme" normal interpediculate distances for each vertebra from the lower cervical level to the sacral region. No minimum normal measurement curve was plotted. It was found that the first three cervical pedicles could almost never be adequately visualized for measurement and that frequently the fourth, fifth, and sixth cervical were visualized with difficulty. Particular attention was also called to the fact that differences in the interpediculate distances from one level to the next of the magnitude of 2 to 4 mm. cannot readily be detected without actual careful measurement. Differences of 1 mm. can safely be allowed as coming within the limits of normal error in measuring.

Anderson and Carson (1) in their excellent recent review, Camp (2) in a paper some years ago, and Olsson (7), among others, have stressed the importance of careful measurement of the interpediculate spaces. Camp, particularly, notes the value of change in contour of the pedicles.

Anderson and Carson make the significant point, perhaps too little known, that physical and neurological findings may

[1] From the Departments of Radiology and Pediatrics, Washington University School of Medicine, St. Louis, Mo. Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif. Dec. 5–10, 1954.

be minimal even after definite roentgenographic changes are detectable. Even the spinal fluid examination and Queckenstedt test may be equivocal after x-ray findings are positive and clear-cut. In several cases in the literature minimal symptoms were present over a period of years before a diagnosis was made, though a review of films revealed diagnostic local widening of the interpediculate spaces early in the disease.

It has been shown (1) that a high percentage of infants and children with spinal cord tumors reveal pathological roentgen diagnostic changes at the appropriate level. Many of them have no changes aside from those in the interpediculate spaces.

French and Peyton (6) reported normal interpediculate measurements from the seventh thoracic to the fifth lumbar vertebral level in 50 children from birth to five years and in 50 children from five to ten years of age. Since no similar study and no study of the entire spine was discovered in the literature, the present investigation was undertaken, in the belief that normal interpediculate distance curves in children from birth to twelve years should be of considerable diagnostic value.

Two-hundred and fifteen children taken at random from the Washington University Clinics and from the wards of St. Louis Children's Hospital were studied, age being the only basis of selection aside from care to exclude children in whom

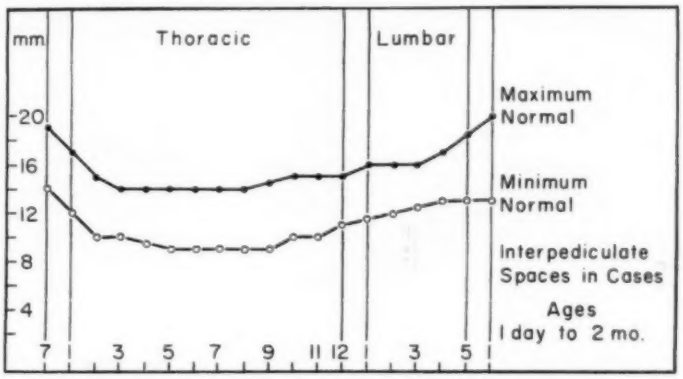

Fig. 2. Normal maximum and minimum interpediculate space measurements for 40 infants one day to two months of age.

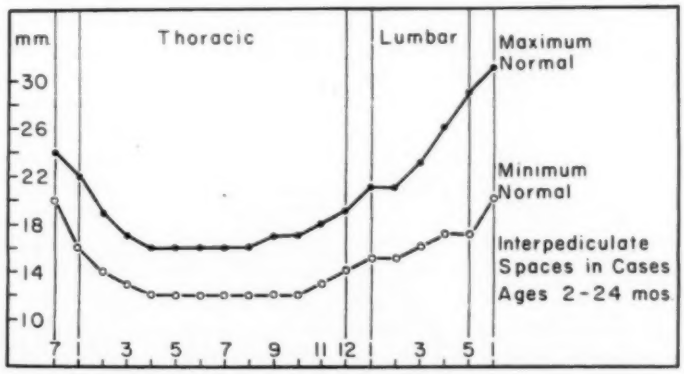

Fig. 3. Normal maximum and minimum interpediculate space measurements for 75 infants two months to two years of age.

neurological or spinal column disease was suspected. Approximately equal numbers of boys and girls were included. The number of colored children was slightly higher than would be expected from their percentage in the population because of a focal-spot-film distance of 30 inches, though he noted that an increase to 36 or 41 inches produced insignificant differences in the interpediculate space measurements. Thirty-six inches was chosen for this study as a more nearly standard modern technic.

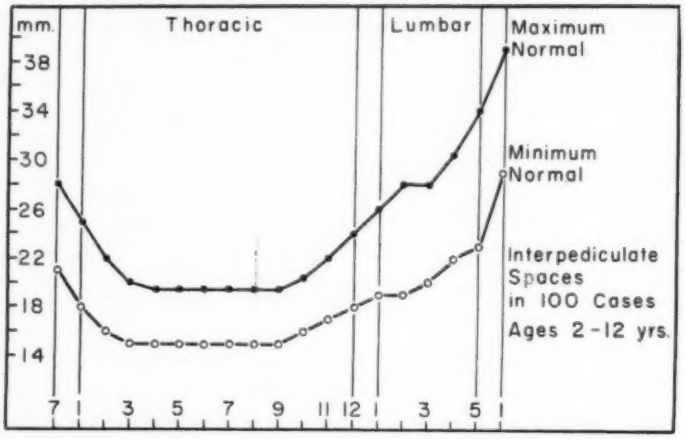

Fig. 4. Normal maximum and minimum interpediculate space measurements for 100 children two to twelve years of age.

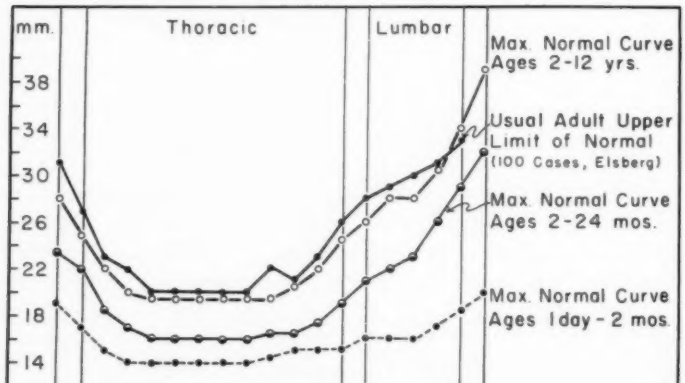

Fig. 5. Composite graph of normal maximum interpediculate measurements for all age groups.

exclusion of private patients from the series.

Anteroposterior and lateral films of the entire spine were made, with a focal-spot-film distance of 36 inches in all cases. In this respect the technic varied from that in Elsberg's original study, since he used

The distances between the inner margins of the two pedicles of each vertebra were carefully measured on the x-ray film with calipers and an accurate steel millimeter rule. It was determined by experimental study on a dried specimen that the inner border of the ring of sclerotic-appearing

bone about the pedicle in the anteroposterior projection is the actual outer edge of the spinal canal. Particular attention was paid to the measurement of the smallest distance between the two inner borders in order to be certain that the spinal canal was being measured at its narrowest point at each vertebral level.

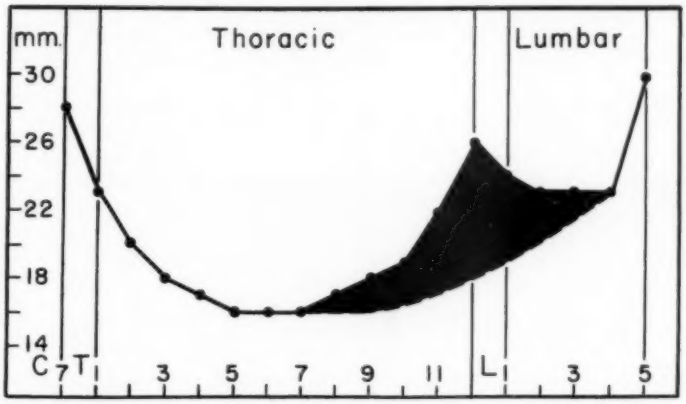

Fig. 6. Abnormal interpediculate space curves of normal twelve-year-old female (Case 1) superimposed on expected normal curve. The shaded area indicates the long abnormal segment in this case. The child was asymptomatic, and spinal fluid studies and Queckenstedt test were negative.

An attempt was made to measure the anteroposterior diameter of the spinal canal, but no consistently accurate posterior check point could be determined because of overlapping ribs, transverse processes, and arches. In spite of this, it should be noted that a localized increase in the anteroposterior diameter of the canal is of great diagnostic importance and that every effort should be made to obtain this measurement on carefully exposed and positioned films in individual cases under study.

The actual contour of the pedicles in the anteroposterior projection varies from concave to oval or circular. A great majority of the pedicles are somewhat oval in contour although many have a more or less flat inner border. This is particularly true in the lower thoracic region. Relatively flat inner borders will thus be noted frequently enough that, if the patient is asymptomatic, their occurrence alone does not justify the conclusion that a pathological change is present. If, however, there is an increased interpediculate distance or a break in the smooth interpediculate space curve at the level in which there is a flat pedicle, added significance for the diagnosis of tumor is inherent. Concave inner borders are unusual; if they occur in the cervical or upper six thoracic vertebrae, they are of diagnostic significance.

It cannot be stressed too strongly that a localized increase in the size of one or more interpediculate spaces is of great significance even though the measurements are still well within the limits of normal for the patient's age group. This is particularly true of a sudden increase of the magnitude of 2 to 4 mm. in an area where the measurements should remain relatively constant, such as the mid-thoracic and upper lumbar areas. Accordingly, it becomes apparent that to have a normal curve available for comparison with the curve of any individual case is important. The curve plotted for the individual case may not correspond to the standard curve at any given point, but its form will correspond to the standard for the age group and allow prediction of expected normal values in any areas in question.

Elsberg and Dyke stated that they had never seen a case in which localized

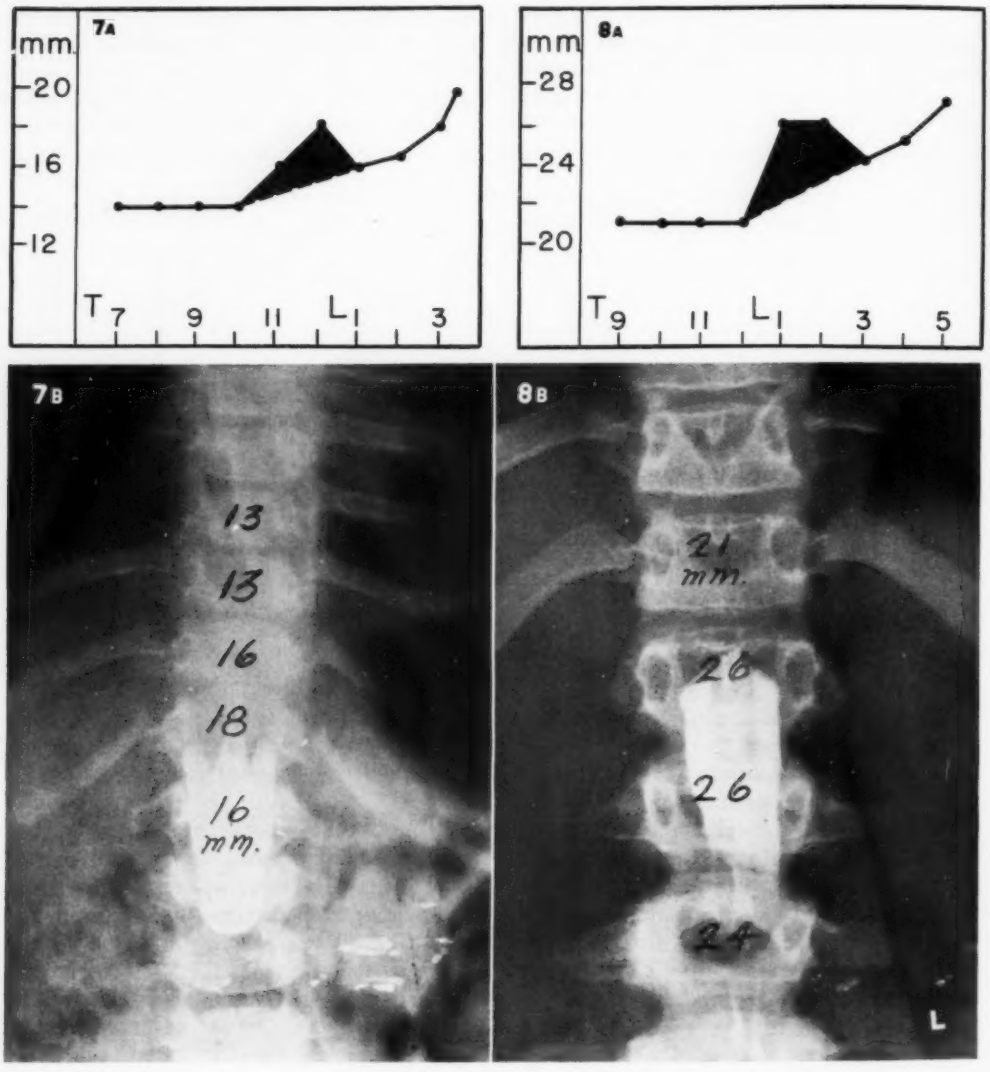

Fig. 7. A. Interpediculate space curve in a case of spinal cord tumor (Case 2) superimposed on expected normal curve. The base of the shaded area indicates the normal values in the tumor area.

B. Myelogram in Case 2 showing total block and wide interpediculate space at the twelfth thoracic level. The medial borders of the pedicles are neither flattened nor thinned. A gelatinous intramedullary astrocytoma of the conus was found.

Fig. 8. A. Interpediculate space curve in a case of spinal cord tumor (Case 3) superimposed on expected normal curve. The base of the shaded area indicates the normal values in the tumor area.

B. Myelogram in Case 3 showing total block and wide interpediculate space at the first lumbar level. The medial borders of the pedicles are neither flattened nor thinned. An extradural neuroblastoma was found at operation.

increase in the width of the interpediculate space occurred in the absence of a tumor. One such case, however, is tentatively included in this series (Case 1, Fig. 6). It should be noted that the increase in the interpediculate spaces in this instance extends over a great segment of the spine, from the seventh thoracic to the fourth lumbar level. It may well be that further study will disclose other similar cases to

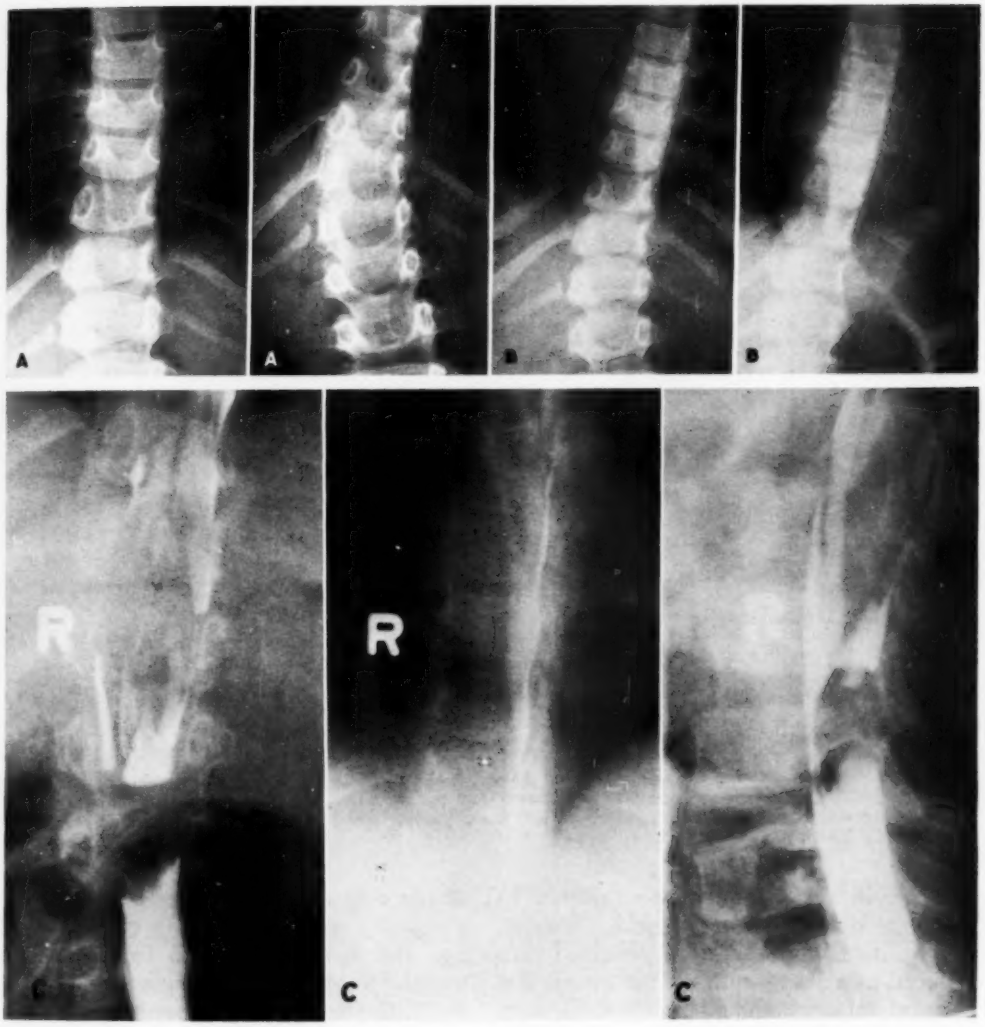

Fig. 9. Case 4. A. Anteroposterior films made in July 1950 and June 1951. These were misinterpreted as showing only slightly increased scoliosis. Neurologic findings were inconclusive. The spinal fluid examination was negative.

B. Anteroposterior films made in February 1953 and October 1954. The widened interpediculate spaces and erosion of the medial borders of the pedicles have become obvious. The spinal fluid protein had reached 400 mg. per cent.

C. Myelograms showing multiple extensive cystic and tubular filling defects. At operation, a far advanced syringomyelia extending from the second to the twelfth thoracic vertebral levels was found. Enough astrocytic gliosis was present to give the gross impression that an astrocytoma was present.

substantiate the impression that a more localized increase above normal is of greater diagnostic significance.

When this study was in the planning stage, it was anticipated that some of the children of the same age would be in different stages of growth. Accordingly, it was decided to determine an "estimated physical age" for each child on the Wetzel grid and to divide the age groups according to this "age" rather than the actual chronological age. For example, an underde-

veloped child of three might well have an "estimated physical age" of less than two, placing his interpediculate space curve in a group entirely different in magnitude and form than might be expected from chronological age alone.

One-hundred and twenty-five of the children in this study were subjected to analysis by the Wetzel grid. Height, weight, age, and sex were obtained and reduced to a standard basis for correlation of skeletal growth with physical age. Both the infants' and children's grids were used, with interpolations according to instructions. Sixty of the children were females and 65 were males. The sex of each individual case was correlated on the grid to obtain the proper auxodromes.

Of the total group of thirty-eight infants under two years, 30 were in the normal physique channels on the grid, but only 27 were in normal auxodromes. Of the remainder, 10 were in the premature auxodrome and 1 in the advanced auxodrome. Hospitalized infants showed the greatest discrepancy between body physique and developmental level as a result of the effects of underlying disease. The age of those falling in the premature auxodromes was reduced to the standard physical age for their particular height and weight. This necessitated the conversion of 10 patients to a younger age group. In other words, 26 per cent of the infants under two were physically younger than their chronological age and 4 were removed from the two months-to-two years group and placed in the birth-to-two months group for purposes of this study.

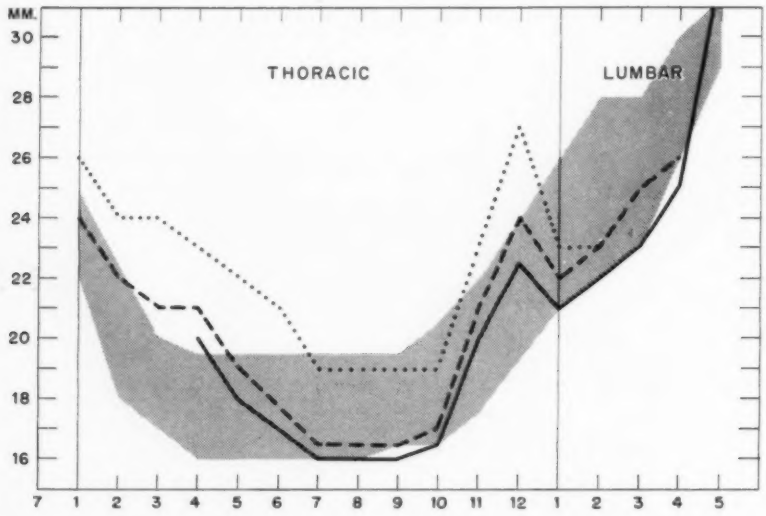

Fig. 10. Composite graph showing the progressive deviation from normal of the interpediculate space measurements in Case 4 from age six to ten. The shaded curve represents normal variation in the patient's age group. —7-26-50 to 6-6-51, — — — 2-25-53, ... 10-13-54.

In the age group from two to twelve years, 22 of 87 children (25 per cent) were reduced to a younger age bracket and 28 (32.5 per cent) were physically advanced for their chronological age. Only 3, however, were placed outside the large two-to-twelve years group by virtue of being "downgraded" on the Wetzel grid.

As the children in this series were studied and measured, it became apparent that the interpediculate space curves were falling quite naturally into three distinct groups. The first of these consisted of infants in a birth-to-two month group

(Fig. 2). The second comprised children in a two-to-twenty-four months group (Fig. 3), and a third large group was made up of children between two and twelve years (Fig. 4).

French (5), in a personal communication, has indicated that his impression was "very similar. . .that the measurements fell rather naturally into three stairstep groups, the first being the first few months of life, the second from a few months to two years, and the third from two years on to twelve years."

It is interesting to note the change in the contour of the curves as they are plotted for the successively older age groups. Thus, the adult characteristic of marked widening of the interpediculate spaces in the cervical and lumbar regions appears progressively more apparent and typical in the years beyond two as the disproportionate growth of the extremities is accelerated.

SUMMARY

Spine films of a large group of normal children from birth to twelve years of age were examined to establish normal interpediculate space values and curves. Three clear groups—from birth to two months, two months to two years, and from two to twelve years—were discovered, and individual curves were plotted for each group, as well as a composite graph for all age groups. One case of an apparent normal variation from the usual curve and 3 cases of spinal cord tumor illustrative of the use of the curves are included.

4952 Maryland Ave.
St. Louis, Mo.

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SUMARIO

El Espacio Interpediculado Normal en los Raquis de Lactantes y Niños Mayores

Estudiáronse radiografías raquídeas de un grupo numeroso de niñas normales desde el nacimiento hasta la edad de doce años a fin de establecer valores y curvas normales del espacio interpediculado. Se descubrieron tres grupos bien definidos—desde el nacimiento hasta los dos meses, de dos meses a dos años y de dos a doce años—y se trazaron curvas separadas para cada grupo, así como una gráfica compuesta para todos los grupos. Un caso de aparente variación normal de la curva habitual y 2 casos de tumor de la médula espinal demuestran el uso de las curvas.

Spontaneous Rupture of Mediastinal Dermoid Cysts into the Pleural Cavity

Report of Two Cases[1]

STEPHEN J. HANTEN, M.D., THOMAS F. KEYES, M.D., and RALPH R. MEYER, M.D.

To quote Willis (1), "a teratoma is a true tumor or neoplasm composed of multiple tissues foreign to the part in which it arises." Dermoid cyst is merely a synonym for benign cystic teratoma. After the ovary and testis, the commonest site for teratoma is the mediastinum, where the tumor is found almost invariably in the anterior portion and is almost always of the benign cystic type.

All teratomas are probably congenital. Because of their inaccessible location and small size at birth, mediastinal teratomas are usually not discovered much before the twentieth year of life, and frequently not until after the age of thirty. Benign cystic teratomas grow slowly and progressively, in the course of years accumulating large quantities of sebaceous fluid, teeth, hair, skin, bone, cartilage, etc. In adult life, even when the tumor attains considerable size, symptoms are usually absent. A mediastinal dermoid may be an incidental finding in chest films taken for unrelated symptoms or during a routine survey.

Symptoms may not develop until spontaneous rupture occurs. This latter event is probably the result of high intracystic pressure from accumulated fluid or of necrosis of the cyst wall from interference with its blood supply. One of these factors, or both, probably leads to rupture into a bronchus, into the pericardium, aorta, superior vena cava, pleural cavity, the neck, or onto the chest wall.

Reports of spontaneous rupture of mediastinal teratomas are scarce. The writers could find but one recorded case of spontaneous rupture of dermoid cyst into the pleural cavity (Wheeler, 2). Recently, however, they have encountered 2 patients, each with a dermoid cyst of the anterior mediastinum which spontaneously ruptured into the right pleural cavity.

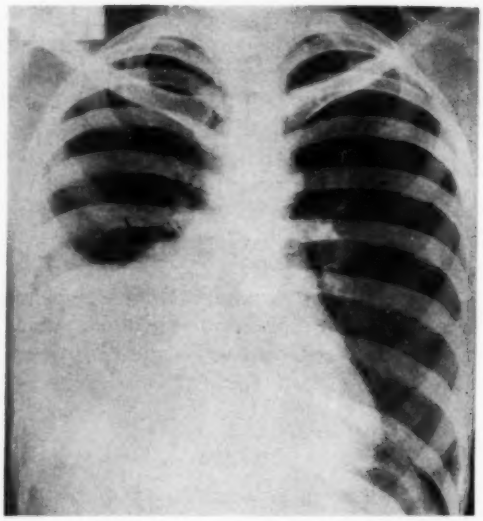

Fig. 1. Case I. Roentgenogram (Oct. 2, 1948) showing a pleural effusion in the basal third of the right chest. Just above the fluid, medially and extending outward from the right hilus, there can be seen a portion of a soft-tissue mass (arrow).

CASE REPORTS

Case I: D. O., a 19-year-old unmarried white female, was first admitted to the hospital on Sept. 27, 1948, because of sudden onset of severe right chest pain and shortness of breath of three hours duration. Except for occasional "colds," she had been in good health until the present illness. She was well developed and well nourished, but in acute distress, dyspneic, and slightly cyanotic. Abnormal findings were confined to the inferior third of the right chest, where there were decreased breath sounds and percussion dullness. The temperature was 100.2° on admission and remained normal thereafter. The blood count was normal and the blood Kahn test negative.

The initial chest roentgenogram, Oct. 2, 1948,

[1] From the Salt Lake County General Hospital and Holy Cross Hospital, Salt Lake City, Utah. S. J. H., Department of Radiology, Salt Lake County General Hospital; T. F. K., Department of Surgery, and R. R. M., Department of Radiology, Holy Cross Hospital. Accepted for publication in March 1954.

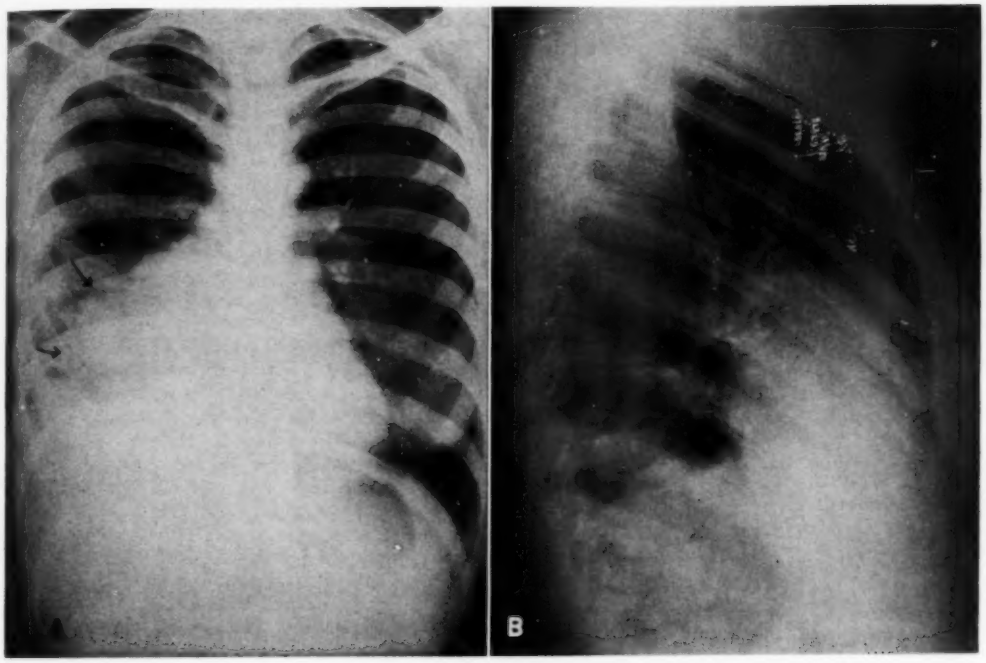

Fig. 2. Case I. A. Chest roentgenogram (Oct. 4, 1948) following thoracentesis, showing a much larger mass (arrows) than would have been suspected from the original film (Fig. 1). It blends imperceptibly with the right heart border. The lateral view (B) establishes the anterior location of the tumor, but its exact definition is difficult because of the obscuring cardiac shadow.

demonstrated a moderate amount of fluid in the base of the right chest and a right anterior mediastinal soft-tissue mass was partially revealed (Fig. 1). Thoracentesis produced 200 c.c. of straw-colored fluid containing a few white cells without bacteria on smear or culture. Following this, a roentgenogram (Oct. 4) showed a clearly defined large anterior mediastinal mass projecting well into the basal portion of the right chest and blending imperceptibly with the right cardiac border (Fig. 2).

On Oct. 5, the patient was discharged for convalescence at home in preparation for surgery. After ten days she was re-admitted to the hospital because of recurrence of right chest pain and dyspnea. Physical and x-ray signs of fluid in the base of the right chest were again present. The mediastinal mass was unchanged. A rubber catheter was inserted into the right posterior tenth interspace, resulting in persistent drainage of straw-colored fluid and greenish sebaceous material. Two sputum cultures were negative. The blood picture remained normal. Bronchoscopy showed decrease in the caliber of the right main bronchus from external compression. Culture of bronchial secretions was negative.

The preoperative diagnosis was right-sided intrathoracic tumor. A right thoracotomy, performed Oct. 26, demonstrated a generally edematous, moderately thickened pleura made up of firm yellowish fibrin dotted with small particles of sebaceous material. At the base of the chest large masses of fibrin and sebaceous material were visualized, interspersed with collections of clear yellowish fluid. A large cystic mass lay in the anterior mediastinum against the ascending aorta. It extended to the right of the superior vena cava, to the left across the mid-line, ending opposite the sternal margin. It was firmly attached by fibrinous adhesions to the superior vena cava and the pericardium.

The mass was removed by blunt and sharp dissection. The point of rupture was not obvious, but an area of extreme thinning, 1 cm. in diameter, was found in the cyst wall, which may have been the site of previous rupture. Good re-expansion of the right lung was obtained after removal of pleural fluid and fibrin.

The specimen was a cystic structure measuring $10 \times 8 \times 6$ cm., its outer surface covered by numerous fibrinous adhesions. The cyst wall was made up of a layer of fibrous tissue 2 mm. thick and an inner smooth grayish-yellow membrane. The contents consisted of yellowish cheese-like liquid and a few hairs. Microscopically, the wall was seen to be composed of very vascular fibrous tissue with an inner lining of stratified squamous epithelium. Scattered through the wall were sebaceous and sweat

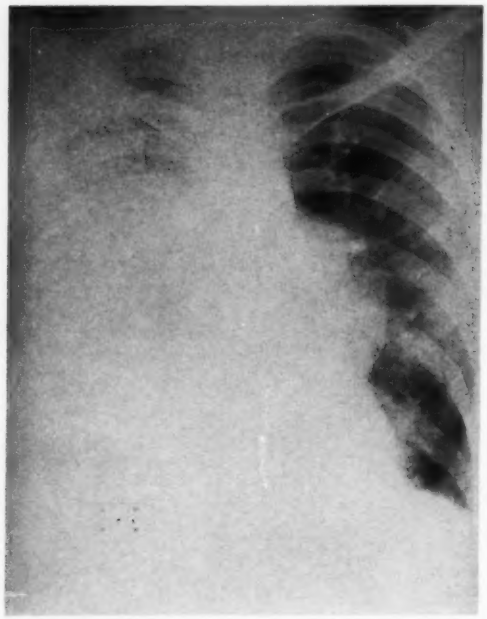

Fig. 3. Case II. Chest roentgenogram (April 15, 1953), demonstrating an extensive right pleural effusion and a large well defined mass projecting from the mediastinum into the left lung field.

glands, lymph follicles, cystic areas, and zones of necrosis.

The postoperative surgical diagnosis was dermoid cyst of the anterior mediastinum with rupture into the right pleural cavity. The pathological diagnosis was dermoid cyst of the mediastinum, benign.

Recovery was uneventful. The patient was discharged asymptomatic on the ninth postoperative day.

CASE II: W. S., a 38-year-old white male, was admitted to the hospital on April 14, 1953. He had been well until two years earlier, when a sudden onset of upper abdominal pain radiating to his left chest caused him to consult his local physician. The diagnosis of coronary occlusion or ruptured peptic ulcer was entertained. An abdominal film was negative. No chest film or other x-ray studies were obtained. Observation made coronary occlusion unlikely. It was thought most probable that the patient had a penetrating peptic ulcer, and he was treated with Banthine and an ulcer diet. His pain subsided in a few days, and he was well until two days prior to hospital admission, when he suffered an acute onset of upper abdominal pain, radiating into the right chest, and shortness of breath.

Examination showed dullness to percussion and impaired breath sounds over the lower two-thirds of the right chest. Admission temperature was 102°, pulse 130, respirations 24. The temperature varied thereafter from 99.4 to 101°. The blood picture was normal except for a slightly elevated white count. X-ray examination of the chest a few hours after admission (Fig. 3) demonstrated a massive right pleural effusion and a large, slightly lobulated anterior mediastinal soft-tissue mass, extending well into the left chest. After removal of 500 c.c. of fluid from the right chest, the mass was seen to extend slightly to the right of the ascending aorta. In the grid film a small triangular density resembling a tooth was visible just to the left of the mid-line and within the mass (Fig. 4). Additional x-ray studies, including an excretory urogram, upper gastrointestinal series, and barium enema examination were negative.

A right thoracentesis on April 15 yielded 500 c.c. of cloudy reddish-brown fluid, which was sterile for all types of organisms but contained mainly polymorphonuclear leukocytes and macrophages. Fat content was not determined. Thoracentesis was repeated on April 17 and 18 and yielded a similar amount of the same type of fluid. Bronchoscopy (April 22) was negative.

The diagnosis prior to surgery was dermoid cyst of the anterior mediastinum with spontaneous rupture into the right pleural cavity.

An anterior transverse thoracotomy, encompassing both thoracic cavities, was performed on May 1, the incision extending along the right fourth interspace, transecting the sternum and the left third interspace. The right pleural cavity was full of loculated grayish fluid; fibrin covered the visceral and parietal pleurae. The loculations were broken up and fibrinous exudate was removed from the right lung and chest wall. With the lung freed, the cyst was entered through a friable area which was thought to be the site of the perforation, and much grayish cloudy material similar to the fluid in the pleural cavity was evacuated. The cyst extended into both thoracic cavities from the anterior mediastinum and was adherent to both lungs, the anterior pericardium, and the thymus gland. It was freed from the lungs by blunt and sharp dissection, but portions of the anterior pericardium and the thymus gland had to be excised in order to effect complete removal. Within the cyst were a few hairs, sebaceous material, and a small amount of calcified debris. Its wall consisted of a squamous epithelial lining, sebaceous glands, and fibrous tissue stroma. No tooth structure was identified. A small "daughter" cyst was found in a removed remnant of the thymus gland. The pathologic diagnosis was dermoid cyst, benign.

Following surgery, the patient made an uneventful recovery. He was well when last seen, Oct. 10, 1953, and a roentgenogram was normal except for minimal residual pleural thickening in the basal half of the right chest.

COMMENT

These 2 cases are believed to be the second and third reported instances of

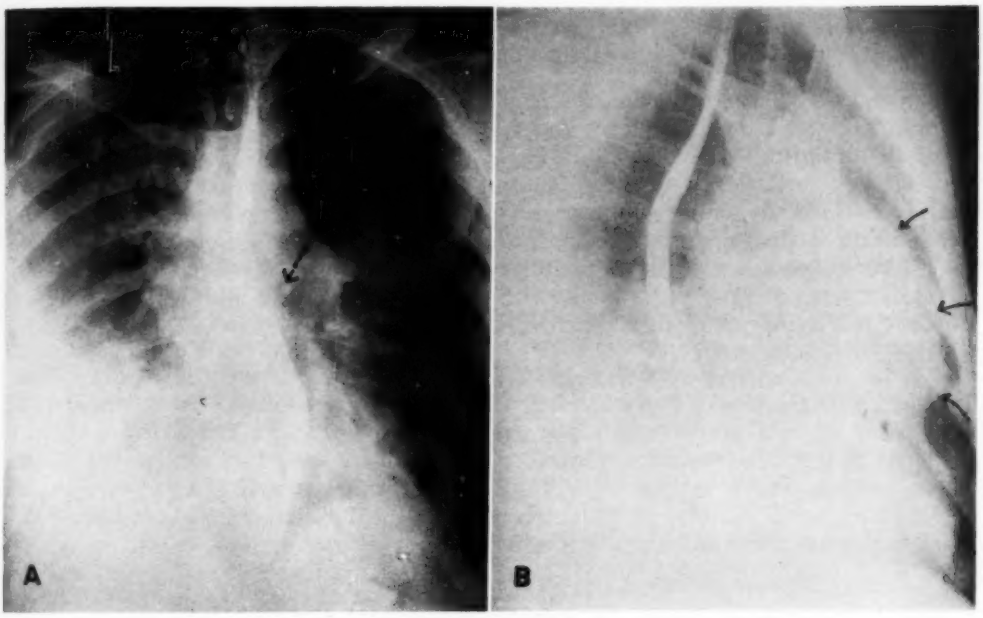

Fig. 4. Case II. Chest roentgenograms (April 15, 1953) after right thoracentesis. The postero-anterior grid film (A) shows that the mass also projects outward from the right hilus (arrows). A small calcific density resembling a tooth is seen overlying the left hilus (broken arrow). A lateral view placed it anteriorly within the mass. Right anterior oblique view (B) shows the mass in the anterior mediastinum.

rupture of a mediastinal dermoid cyst into the pleural cavity. This condition should be considered when in a previously asymptomatic adult sudden chest pain and dyspnea develop and chest films reveal a massive unilateral pleural effusion and an anterior mediastinal mass. The diagnosis becomes likely if teeth or recognizable bony structures, characteristic of a dermoid cyst, are present in the mass. Sebaceous material in the aspirated pleural fluid would confirm the diagnosis. The symptoms must be differentiated from those due to such acute conditions as perforated peptic ulcer, coronary occlusion, and pulmonary embolus.

In the case reported by Wheeler and in the 2 cases presented here, the pleural effusion was on the right side. Study of additional cases would be of interest to see if this localization is a characteristic finding.

SUMMARY

The clinical, laboratory, roentgenologic and surgical findings are presented in 2 cases of spontaneous rupture of a mediastinal dermoid cyst into the right pleural cavity. Only one other case could be found in the literature.

Salt Lake County General Hospital
Salt Lake City, Utah

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(Para el sumario en español, véase la página siguiente)

SUMARIO

Rotura Espontánea de Quistes Dermoideos del Mediastino en la Cavidad Pleural

Preséntanse 2 casos, que parecen ser el segundo y el tercero de la literatura, de rotura de un quiste dermoideo del mediastino en la pleura. Hay que considerar esta afección cuando, en un adulto previamente asintomático, aparecen de repente dolor torácico y disnea y las radiografías torácicas revelan derrame pleural unilateral y una tumefacción en el mediastino anterior. El diagnóstico se vuelve probable si en la tumefacción se observan dientes u otros tejidos óseos reconocibles. La presencia de materias sebáceas en el líquido pleural aspirado confirmaría el diagnóstico. Hay que diferenciar los síntomas de los debidos a ciertas dolencias agudas, tales como úlcera péptica perforada, oclusión coronaria y embolia pulmonar.

Roentgen Demonstration of Psammoma Bodies in Cystadenocarcinoma of the Ovaries

Report of Two Cases[1]

ANDREW P. DEDICK, M.D., and VINCENT M. WHELAN, M.D.
Red Bank, N. J.

THE ROENTGEN appearance of intra-abdominal calcification is important from the standpoint of diagnosis. Opaque foreign bodies, calcification in aneurysms, renal and biliary calculi, dermoids, and similar pathological conditions are usually diagnosed without difficulty. With careful attention to detail, other less common diseases can be detected and their nature correctly predicted. It is well recognized that psammoma bodies occasionally form in papillary growths of the ovary in both the primary and metastatic foci.

In 1936, Loud (2) described a case of multilocular papillary cystadenoma of the ovary in which he proved recurrence by demonstration of psammomatous bodies radiographically. In 1942, Lingley (1) reported 5 cases in which the diagnosis was aided by roentgen examination. Since that time, occasional reports have appeared on the subject, both in this country and abroad.

There are two rather characteristic features of psammoma calcification, as pointed out by Lingley, which help to distinguish it from other conditions: density and distribution.

The characteristic density is less than that observed in almost any other type of calcification, such as fibroids, calcified lymph nodes, and calculi. The psammoma bodies, being very tiny and fairly uniform in distribution throughout the neoplastic region, produce shadows slightly more dense than ordinary soft tissue. With greater degrees of calcification, the density is increased, but usually it suggests that of scattered bismuth or barium several days after ingestion.

In no other condition is the calcific process so extensive. Nathanson (3) reported a case which showed calcification in plaques throughout the entire abdomen, including the liver and even one lung. Other examples have been reported with deposits extending from the diaphragm to the pelvic floor.

It is important to be sure that the patient has not been taking opaque drugs and is not a psychopath addicted to swallowing opaque earths. Such ingested materials can be misleading, although their distribution along the gastrointestinal tract should distinguish them.

CASE I: A 68-year-old white female complained of indigestion and upper abdominal pain, particularly after meals. Her abdomen was tender, and there was a tender mass in the epigastrium. On pelvic examination, the patient was found to have an elongated cervix, without ulceration, and a typical "frozen pelvis." A gallbladder and upper intestinal study was undertaken, and numerous small calcific deposits were demonstrated, scattered throughout the abdomen, apparently confined to the peritoneal cavity. These varied in size and lay outside the intestinal tract (Figs. 1 and 2).

The clinical history, physical findings, and roentgen picture were indicative of pelvic disease which had produced calcification. The density and distribution of the deposits were felt to be in accord with Lingley's observations, and a diagnosis of papillary cystadenocarcinoma of the ovary was suggested.

Laparotomy was done, and generalized carcinomatosis was found, with involvement of the parietal peritoneum, omentum, mesentery, both ovaries, and the liver. Surgery was limited to biopsy, tissue being obtained from the omentum and right ovary. The histologic diagnosis was papillary cystadenocarcinoma with psammoma body formation.

The postoperative course was uneventful and ten days after surgery deep x-ray therapy was instituted. Treatment was given through two anterior 20 × 20-cm. portals over the pelvis and abdomen, a total of 2,000 r/air being delivered to each port in a period of three weeks. The factors were: 200 kv; 15 ma; target-skin distance 50 cm.; h.v.l. 1.2 mm. Cu; added filtration, 0.5 mm. Cu, 1.0 mm. Al. The patient tolerated treatment well and shortly there-

[1] Accepted for publication in January 1954.

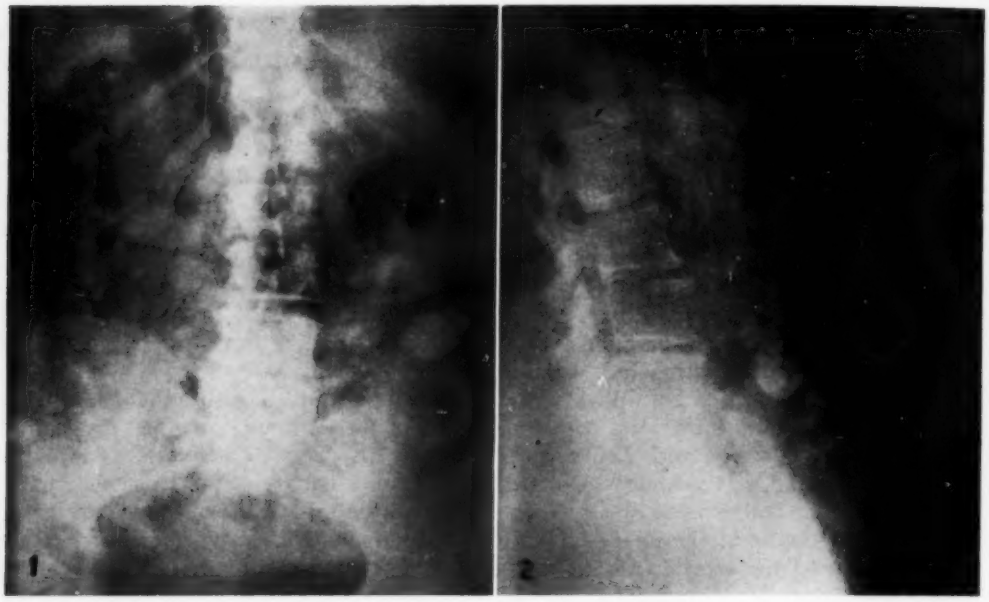

Fig. 1. Case I: Initial anteroposterior scout film showing extensive calcification and the characteristic density. Note the similarity to ingested opaque material.

Fig. 2. Case I: Lateral view of the abdomen showing characteristic density and distribution. A careful history disclosed no previous ingestion of opaque material.

Fig. 3. Case I: Scout film obtained nine months after completion of radiation therapy. Note the diminution of calcific density.

after her appetite and general condition improved. Nine months after completion of irradiation abdominal films showed a considerable decrease in calcification (Fig. 3). Her condition was excellent and she had no complaints.

CASE II: A 71-year-old white female was admitted to the hospital, March 3, 1953, complaining of severe sudden abdominal pain, nausea, vomiting, and constipation. The past history was irrelevant except for removal of a pelvic tumor in June 1947 at another hospital. The abdomen was markedly distended and tender, and on rectal and vaginal examination a pelvic mass the size of a grapefruit was felt. Plain films of the abdomen showed distended loops of large and small intestine, with many fluid levels, suggesting lower left colon obstruction. Shadows of calcific density were demonstrated in the left abdomen and in the region of the right gutter (Fig. 4). A barium enema study disclosed an obstructive lesion at the rectal ampulla (Fig. 5).

Because of the surgical history and the density and distribution of the calcification in the abdomen, it was felt that the patient had an ovarian neoplasm with metastasis. Cystadenocarcinoma with psammomatous formation seemed likely.

At operation the left ovary was found to be involved in a huge mass, fixed to the lateral pelvic

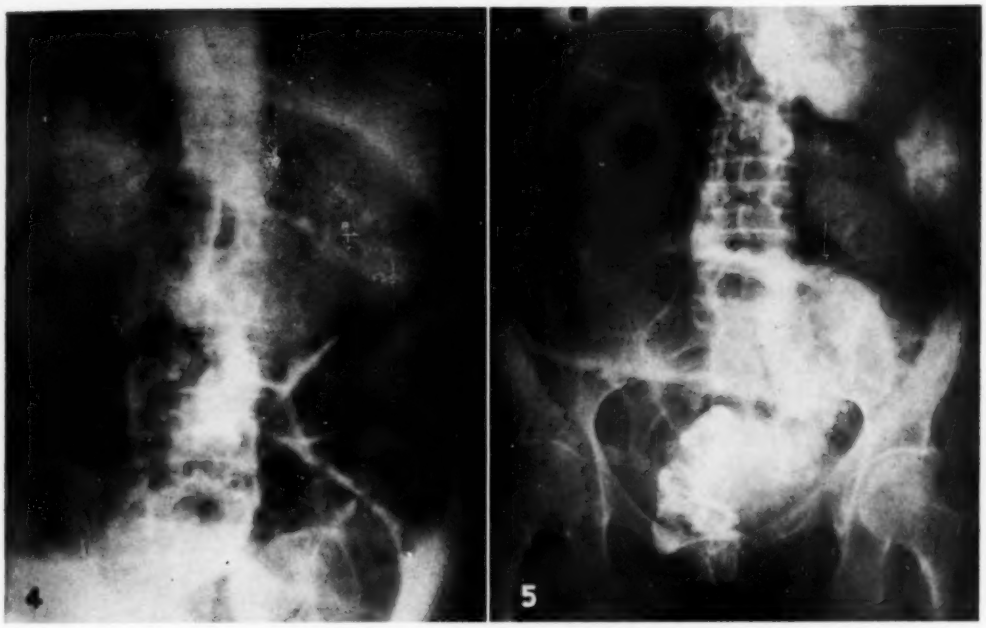

Fig. 4. Case II: Scout film obtained on admission, showing characteristic distribution and density of calcification. The marked large and small intestinal ileus is well seen.
Fig. 5. Case II: Post-evacuation barium enema film, showing the obstructive lesion at the level of the ampulla due to the extrinsic mass found at operation.

wall and to the rectosigmoid. Metastasis had occurred throughout the retroperitoneal area and involved the liver and mesentery. The peritoneal cavity was filled with a sanguineous fluid. Cecostomy was performed to relieve the obstruction. Thirty-nine days later, after a stormy postoperative course, the patient died. Radiotherapy had not been attempted.

The operative report was as follows: "The gross surgical specimens consisted of the left tube and ovarian mass, measuring 10 × 6 × 5 cm., and the appendix. The cut section showed two large and several small cysts, the largest of which presented small papillary projections and contained coagulated albuminous fluid. The appendix showed fibrosis and a small white area beneath the serosa.

"Microscopically, there was a Grade I papillary cystadenocarcinoma of the ovary with transplant to the appendix. Numerous corpora amylacea were found in the appendix."

SUMMARY

The formation of psammoma bodies occurs occasionally and in the abdomen is limited to benign papillary cystadenoma and papillary cystadenocarcinoma of the ovary. The density and distribution of the psammomatous bodies as determined roentgenologically are characteristic and should lead to the diagnosis of the ovarian lesion.

67 E. Front St.
Red Bank, N. J.

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(Para el sumario en español, véase la pagina siguiente)

SUMARIO

Observación Roentgenológica de Cuerpos de Psamomas en el Cistadenocarcinoma de los Ovarios. Presentación de Dos Casos

De vez en cuando obsérvanse en el abdomen cuerpos de psamomas, asociándose con tumores papilares del ovario: cistadenoma benigno y cistadenocarcinoma primario y metastático. Roentgenográficamente, pueden distinguirse de las calcificaciones abdominales de otros géneros por su típica densidad, que apenas excede la del tejido blando ordinario y por su extensa distribución, fuera del tubo gastrointestinal.

El descubrimiento de calcificación de esta forma debe conducir al diagnóstico de tumor ovárico. Comunícanse 2 casos.

Benign and Malignant Gastric Ulcers: Roentgen Differentiation

An Analysis of 142 Cases Proved Histologically[1]

ISRAEL E. KIRSH, M.D.[2]

IT HAS LONG BEEN considered that the differentiation of benign and malignant ulcerative gastric lesions is a problem to which the roentgenologist can make an important contribution, if not a decisive one. Recent improvements in technic make x-ray examination of the stomach more useful than ever before. On the other hand, the opinion has been expressed, occasionally in print and even more often verbally, especially by surgeons, that the radiologist's report is so frequently unreliable that it would be best to remove the ulcer at once, even though it appears benign roentgenographically, for fear of missing a malignant lesion. Quoted in support of this view are statements, often based on old clinical studies, that ulcerative lesions in certain locations, or of a certain size, are likely to be malignant, and that some lesions having the gross appearance of benign gastric ulcers showed carcinoma under the microscope.

It seemed useful, therefore, to determine how often malignant gastric lesions were misdiagnosed as benign in a large series of unselected cases examined in the x-ray department of this hospital. This series includes all the ulcerative gastric lesions, both benign and malignant, found in routine x-ray examinations in a period of five years and checked at operation or autopsy with histologic study.

An attempt will be made to evaluate the roentgen examination as a whole, and a number of x-ray criteria separately, as concerns the benignity or malignancy of the ulcerative lesion.

HISTORICAL BACKGROUND

It is worth remembering that, in the course of time, some medical dicta which have attained authority by frequent repetition may be changed as a result of experience. It has long been taught, for instance, that when an ulcer crater is large, the lesion is probably malignant. MacCarty (1), in 1940, repeated an opinion he expressed in 1909, as follows, "I am quite sure that at least 90 per cent of all chronic gastric ulcers larger than a quarter (2.5 cm. in diameter) are definitely cancers." A recent paper by Lumsden (2) reports very different observations: of 15 ulcers exceeding 3 cm. in diameter, 11 were benign. Marshak, Yarnis, and Friedman (3) recently described 7 cases of benign gastric ulcer in which the crater exceeded 3.5 cm. in diameter. All of these ulcers penetrated into the pancreas, liver, or mesentery, producing an indurated mass simulating carcinoma at operation. Ledoux-Lebard *et al.* (4) found that 24 out of 28 (86 per cent) of their "giant" ulcers (over 3 cm. in diameter) were benign.

Another statement frequently made is that ulcers of the greater curvature of the stomach are almost always malignant. It is here quoted in its most dramatic form (Sproull (5)): "It is probably unwise for a roentgenologist to diagnose a greater curvature lesion as benign peptic ulcer. The chance of the diagnosis being correct is very small—probably one in a million." This generalization was made on the basis of a single case, which, from inspection of the illustrative roentgenograms, could be called grossly malignant (since the ulcer was within a filling defect, which the author called spasm, even though it persisted for six months). In spite of the alleged one-per-million incidence, the literature contains not a few reports of one (or two) proved benign greater curvature ulcers (6–16). Several series of greater curvature lesions have also been reported (17–23),

[1] From the Department of Radiology, V.A. Hospital, Hines, Ill. Accepted for publication in April 1954.
[2] Physician-in-Charge, Diagnostic X-ray Department, V.A. Hospital, Hines, Ill.

in which the percentage of malignancy varied considerably. Bowers and Rivers (17) found 100 per cent of 4 greater curvature ulcers to be malignant. In Ransom's series (23), 20 per cent of 5 lesions were malignant; in the present writer's, 25 per cent of 8. It is of interest that in the Hines Hospital group of greater curvature lesions, those which appeared benign on the x-ray films all proved to be benign; 2 malignant lesions showed evidence of malignancy on the films (Fig. 3); 2 "suspicious" lesions were actually benign. In other words, no benign appearing lesion was in fact malignant.

At a recent surgeons' symposium (24) on gastric ulcer, Gray of the Mayo Clinic stated that greater curvature lesions are no longer assumed to be malignant, and C. E. Welch pointed out that "now" (November 1953) statements in print about the relation of size and location of an ulcer to its malignancy must be taken with reservations.

The position of an ulcer in the stomach has been related to malignancy in other respects also. Allen (25) stated that 65 per cent of all ulcers in the 2 cm. proximal to the pylorus were malignant regardless of size. Singleton (26), however, in a large series of ulcerative lesions found that, of 15 located in the prepyloric inch, 7 proved benign histologically, following resection, while the other 8 healed completely on medical treatment. Gutmann *et al.* (27) believed benign ulcer to be more frequent in the vertical portion of the lesser curvature, malignant ulcer in its horizontal part, including the gastric angle. Boudreau, Harvey, and Robbins (19), in a study of gastric ulcers found at autopsy, said that two-thirds of all the prepyloric lesions were benign. Sussman and Lipsay (28) thought that ulcers in the cardia and the anterior and posterior walls were more likely to be malignant but admitted that this was not of help in an individual case.

RADIOGRAPHIC CRITERIA OF MALIGNANCY IN GASTRIC LESIONS

Gutmann and his associates, in a book (27) describing gastric carcinoma in its inception, to which the writer has seen no reference in the American literature, presented in considerable detail the radiographic features of malignant ulcer. They list the plateau niche, and the broad-based triangular niche, as well as the *niche en-castrée*, for which the best English equivalent is perhaps "niche in a notch." The notch is a depression limited by two rigid shelves, either sloped or with straight borders, and is due to a limited infiltration of the wall without a definite mass. The notched appearance is a sign of malignancy, even when it is not associated with ulcer; here it is of interest in association with an ulcer niche.

Sussman and Lipsay (28) state that the niche may be irregular or triangular in the presence of a malignant lesion and that the mucosal folds may be stiff, irregular, widened, or ironed-out. A nodular or irregular ulcer base cannot be assumed to be due to cancer, according to these authors, since blood clot, granulation tissue, and food particles may produce irregularity in benign ulcers also.

Decrease in size of the niche cannot be relied upon as meaning a benign ulcer, in the opinion of Hellmer (29), who saw 4 malignant cases in which the crater definitely became smaller preoperatively. He states that the only way to be sure, radiologically, that an ulcer is benign is to follow it to complete healing, with nothing left which could indicate carcinoma.

MATERIAL

This paper is based on a study of the clinical records and roentgenograms of all benign gastric ulcers examined roentgenologically and proved histologically in this hospital, in a period of over five years. There were 120 such ulcers, in 116 patients. The malignant ulcerative lesions, 22 in number, were found by reviewing the clinical records and roentgenograms of the 209 cases of proved gastric carcinoma and sarcoma seen in the same period. In these cases, the lesion was predominantly ulcerative, all those cases being excluded

which showed an obvious tumor on the films, even if an ulcer were also present. Included in the statistics are 2 false negative cases, that is, cases in which in spite of negative x-ray findings operation was performed and a benign ulcer was found. In 2 other cases, not counted in the series, an ulcer was reported on roentgen examination and none was found by the surgeon on gross inspection of the stomach. In these cases no histologic report was obtained, only gastrotomy having been done. It is possible that the ulcers had healed in the interval between positive x-ray examination and negative surgery. To summarize, 142 ulcerative lesions of the stomach were examined by x-ray, removed surgically, and verified histologically. Of these, 120 were benign, 22 malignant.

PROCEDURE

In analyzing the roentgenograms, the location of the ulcer was tabulated, as well as the diameter of the crater and the presence or absence of a variety of features which are considered to have a bearing on the possibility of malignancy. For each ulcer the following observations were made: location, penetration beyond the lumen, undermining, filling defect, abnormal folds, diameter of crater, irregularity of base, radiation of folds, incisura, duodenal ulcer deformity, gastric retention, and x-ray evidence of healing at stated intervals. The findings on the initial examination and subsequent changes were noted. From the records were obtained the radiologist's report, as well as the gastroscopic, operative, and pathological reports. It was also recorded whether the x-ray report was considered positive for malignant disease or called for repeat or special study because of suspicion of malignancy. A separate note was made if, on review of the films, a malignant lesion could have been correctly reported, in the opinion of the writer; that is, if an error could be said to have been made in the original x-ray interpretation. It should be mentioned that the reports were not all made by one radiologist, but by the various members of the department, most of whom were residents in radiology.

The location of the lesion was considered under two headings: (*a*) proximal, middle, or distal third; (*b*) lesser curvature, greater curvature, or anterior or posterior surface. The diameter of the crater was tabulated as measured on the films, in centimeters, but in the table summarizing the findings the size is listed as 2.5 cm. and over, or less than 2.5 cm. in diameter, because of the references to this criterion in the literature. The location of the lesion at operation was accepted as the correct one unless it was changed by the pathological report. The latter report, as is customary, was based on gross and histologic study, only routine microscopic sections being made. While some writers state that multiple histologic sections should be made of different parts of the ulcer edge, in order to rule out a small malignant area, it is not believed that this would significantly change our results. We have encountered, in a follow-up of varying duration, no case in which an initial histologic diagnosis of benign lesion was subsequently changed to malignant, although in one case the microscopic slide of a lesion at first considered malignant was later reviewed because of the long survival of the patient, and a final diagnosis of benign ulcer was reached.

RESULTS

(1) *Valuable Signs for Differentiation. Sign of Benignancy:* A very useful sign is the presence of radiating folds which can be followed to the very edge of the crater (Fig. 1). This was found in 50 of the benign ulcers, and in not a single one of the malignant. If the folds radiate in the vicinity of the crater but are broken off immediately around it, a malignant lesion should be considered (Fig. 3). For this determination, good mucosal relief films are, of course, necessary.

Signs of Malignancy: The signs of most value for a diagnosis of malignant ulcer are: (*a*) a filling defect and (*b*) abnormal folds (Fig. 2) near the crater. A filling defect was seen in 19 malignant lesions (out

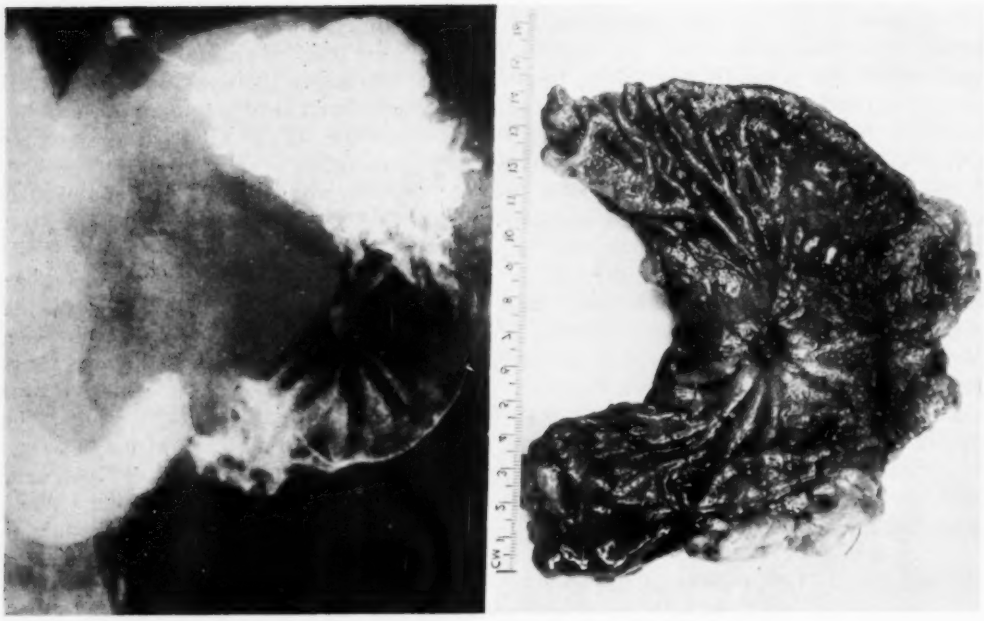

Fig. 1. Benign ulcer. The folds radiate from the edge of the crater.

TABLE I: RELATION OF LOCATION OF ULCER TO MALIGNANCY

	Histologically Benign Lesions	Histologically Malignant Lesions	Total	Percentage Malignant
A. Portion of stomach				
Proximal third	15	5	20	25
Middle third	65	8	73	11
Distal third	40	9	49	18
TOTAL	120	22	142	15
B. Curvature or surface				
Lesser curvature	93	16	109	15
Greater curvature	6	2	8	25
Ant. or post. surface	21	4	25	16
TOTAL	120	22	142	15

of 22). Abnormal folds near the base of the crater were also present in 19 of the malignant group. It should be borne in mind that the first of this pair of signs was present also in 17 of the 118 benign ulcers and abnormal folds in 15 of that group. These signs, therefore, are important, but should not be considered as pathognomonic by themselves. Furthermore, as is known, it is sometimes difficult to decide when a significant filling defect is present or whether the folds are abnormal. In this decision, experience and judgment are important.

(2) *Signs of Little Differential Value. Location:* Table I shows that in no location in the stomach was there a particularly high incidence of malignant ulcers. The highest incidence (25 per cent) was in the proximal third (5 out of 20 ulcers in this region), and the greater curvature (2 out of 8). The prepyloric region was not specifically considered in this tabulation, but this did not appear to differ in any important respect from the distal third, a slightly larger segment, in which the percentage of malignant lesions was 18 per cent.

Size of Crater: The malignant group of lesions showed a higher percentage of large ulcers (41 per cent) than the benign group (20 per cent). However, when one considers the larger ulcers as a group (there were 33 of these), most of them (72 per cent) were benign. It was learned, on further study of the large benign ulcers,

that 20 out of the 23 (87 per cent) were penetrating or adherent, usually to the pancreas. Some of our cases of large benign ulcer had an appearance suggesting the "walled-off perforation" so well described by Feldman (30).

Gastric Retention: The presence of a gastric residue after five hours (this interval was six hours in the first year of the study) was of little diagnostic value. Gastric residue was present in 48 per cent of the malignant and 40 per cent of the benign cases. The interval film, however, was sometimes of value in an unexpected way. Barium was retained in the ulcer crater in 24 of the cases, and there were a few in which the barium-filled crater visible in the five-hour film attracted attention first, leading to more careful study and discovery of the lesion on the other films.

Fig. 2. Malignant ulcer. The crater penetrates beyond the lumen and has a slightly undermined border. Pressure spot film (insert) shows (marked by arrows from above down) filling defect, abnormal folds adjacent to the crater, and the crater itself.

Irregular Crater: The base of the crater was irregular in 7 of the 22 malignant and in 21 of the 118 benign ulcers. The irregularity could be described as lobulation in most of these. In the majority of the benign ulcers with lobulated base, there was penetration into the pancreas.

Fig. 3. Malignant ulcer. The folds have a tendency to radiate, but are broken off close to the crater.

Penetration Beyond the Gastric Lumen: The crater extended beyond the gastric border in 18 of 22 malignant cases (Fig. 2), and in 113 of 118 benign. In ulcers of the anterior or posterior surface, it often was not possible to obtain a profile view of the crater for this determination.

Healing of Ulcer: Repeat roentgen examination was performed at different intervals in a number of our cases. In some cases, not reported here, the response to medical treatment was deemed satisfactory, and gastric resection was not done. In this series, of course, every case was subjected to surgery. The figures given here, therefore, do not reflect the total picture, which would include those cases not requiring surgery.

Of the benign ulcers, 15 showed 50 per cent reduction in size in two to three weeks; 15 ulcers did not. Only 5 ulcers healed completely in two to six weeks; 20 did not disappear in that time. In the malignant group, 1 ulcer showed partial healing in two weeks. Another disappeared completely in six weeks, but a tumor then

TABLE II: INCIDENCE OF CERTAIN RADIOGRAPHIC CRITERIA

	Histologically Benign Ulcers (118 Lesions)*	Histologically Malignant Ulcers (22 Lesions)
A. Criteria useful for differentiation		
Radiation of folds to edge of crater	42%	0
Filling defect near ulcer	14%	86%
Abnormal mucosal folds near ulcer	13%	87%
B. Criteria not useful for differentiation		
Penetration beyond gastric lumen	93%	82%
Undermined border of crater	25%	32%
Normal incisura	10%	0
Irregular base of ulcer	20%	37%
Duodenal ulcer deformity	20%	14%
Crater more than 2.5 cm. in diameter	20%	41%
Crater less than 1.0 cm. in diameter	28%	14%
50 per cent healing in two to three weeks	50%†	20%‡

* In 2 cases of proved benign ulcer, the lesion was not seen on the films, even on review.

† In only 30 of the benign lesions was a gastrointestinal series repeated in two to three weeks.

‡ In only 5 of the malignant group was a gastrointestinal series repeated in two to three weeks.

appeared. In still another malignant lesion, no mass could be seen roentgenographically after complete healing of the ulcer, and resection was done on the basis of the gastroscopic report of malignant ulcer. Four of the malignant lesions showed no change in ulcer size in two to three weeks.

Duodenal Ulcer: Duodenal ulcer deformity was seen in 3 malignant (14 per cent) and 23 benign cases (20 per cent), a difference not large enough to be important. No active duodenal ulcer was seen in any patient of either group.

Undermined Border: The crater had an undermined border or "over-hanging edge" in 32 per cent of the malignant and 25 per cent of the benign ulcers. This sign was therefore of no help in diagnosis.

Incisura: The presence of a normal incisura opposite the ulcer was found to be of little value, since it is infrequently seen. Only 12 of the benign ulcers showed a narrow, sharp incisura. In 23 other benign cases, a broad incisura was present. However, none of the malignant ulcers showed a narrow incisura, and only 3 a broad one. One can say, then, that a normal incisura, when present, means a benign ulcer, but its absence, or the presence of a broad incisura, does not necessarily mean a malignant ulcer.

(3) *Other Signs of Interest.* Certain other signs reported to be useful for the diagnosis of malignant ulcer were not thoroughly evaluated in this study. I learned of these only recently, in reviewing the literature while preparing to write this paper. Consequently, they were not considered when the radiographs of the benign group were reviewed, and it cannot be stated how often, if ever, they were present in these lesions. The malignant group, however, was reviewed with these signs in mind, and they were found in some instances. I refer to three signs of malignant ulcer which were described by Gutmann and his co-workers (27). The first, *niche encastrée*, or "niche in a notch" (described earlier in this paper), was seen in 3 of our malignant cases. A broad-based triangular niche, as seen in profile, was also considered, by the French writers, to be suspicious of malignancy. This is to be distinguished from a triangular niche with narrow base, which may be found during the healing stage of benign ulcer. The sign was present in two of our malignant ulcers. The third sign, plateau-niche, was recognized only once in our malignant group. This is a long, shallow, rather flat niche, with either straight or slightly undulating base.

EVALUATION OF X-RAY EXAMINATION

To place this numerical evaluation in perspective, it should be restated that we are dealing here with only histologically proved ulcerative lesions, almost all of them verified surgically (postmortem examination provided a very small number of these lesions). A larger group than the one analyzed here is that of gastric ulcers followed medically to healing. A still larger group is made up of negative gastrointestinal x-ray examinations in which the x-ray report and the clinical course were in

agreement. In the period of this study, about 24,000 x-ray examinations of the gastrointestinal tract were made in this hospital.

In the benign ulcer group, the x-ray reports agreed with the final diagnosis in 83 per cent of the cases (Table III).

A comparison of the x-ray and gastroscopic reports is of interest. The gastroscopic report agreed with the final diagnosis in 40 per cent of the benign ulcerative lesions and 43 per cent of the entire group (Table III). The x-ray method is one of mass examination, as was noted by Baker, Gorvett, and Spellberg (31), and is done before gastroscopy. At this hospital, the x-ray films and report are always made available to the gastroscopist before the instrument is inserted.

A question of clinical importance concerns the number of malignant ulcers not correctly classified in the x-ray report. This number is 16, or 11 per cent of the entire series of 142 ulcers (malignant and benign). That is, of 142 ulcerative lesions, 6 were correctly considered malignant on the first examination, and 16 were not so diagnosed. However, 7 out of the 16 were considered suspicious of malignancy and a repeat gastrointestinal series was advised. In only 9 of the malignant lesions, or 6 per cent of the entire series, was a malignant lesion neither diagnosed nor suspected by x-ray. The films in these 9 cases were reviewed after the pathological reports were known. In 7 of the 9, it is believed that the films contain data from which a correct diagnosis might have been made. Of the other 2 lesions, 1 was in the cardia, showing a large superficial crater with ill-defined filling defect. Two weeks later nothing abnormal was seen in this location. In the remaining case, the mucosal pattern was obscured by active bleeding.

The method of x-ray examination has changed significantly during the period covered by this study. At the beginning of the five-year period, spot films were not routinely made, but later a mucosal relief technic was used, and this was employed routinely during the past three years.

TABLE III: EVALUATION OF ROENTGENOGRAPHY AND GASTROSCOPY IN POSITIVE CASES

	Histologically Benign Ulcers	Histologically Malignant Ulcers*	All Ulcerative Lesions
X-ray Report			
Benign ulcer diagnosed	99	9†	
Malignant ulcer suspected	4	7	
Malignant ulcer diagnosed	11	6	
Gastric ulcer not seen (or reported in duodenum)	6		
Number of lesions examined	120	22	142
X-ray report in agreement with histology	83%	28%‡	76%
Gastroscopy Report			
Benign ulcer diagnosed	33	1	
Malignant ulcer suspected	14		
Malignant ulcer diagnosed	4	10	
Ambiguous report or unsatisfactory examination	5	1	
Gastric lesion not seen	26	5	
Number of lesions examined	82	17	99
Gastroscopy report in agreement with histology	40%	59%	43%

* From this group were excluded those cases in which the roentgenograms showed obvious gastric tumors, even when accompanied by ulcers.

† On review of the x-ray films of these 9 lesions, 7 were considered positive or suspicious for malignancy.

‡ Here we obtain 59 per cent if we count "suspected malignancy" as well as a definite diagnosis of malignant ulcer.

What is the importance of investigating the roentgen differentiation of benign and malignant ulcers? As roentgenologists, we are expected to contribute to the problem of the management of the patient with gastric ulcer. It is not enough to diagnose malignant ulcer when the findings clearly indicate it. The patient also benefits when the x-ray examination results in a clear-cut diagnosis of benign ulcer. Such a diagnosis supports the clinician in his effort to pursue a course of medical therapy. When this is successful, the patient has been spared surgery with its risks and its train of symptoms due to disturbed physiology. This is not to say that the x-ray report can always

be definite. There will inevitably be some reports showing inability to rule out possible malignancy. In that event, repeat examination after a few weeks may clarify the situation. If not, the decision as to operation must be made by the clinician on the basis of all the facts. But to the extent that a technically good examination (including mucosal spot films) is made, and reliable diagnostic criteria thoughtfully applied, the x-ray method will be valuable in reaching an accurate diagnosis.

SUMMARY

1. An analysis was made of the roentgen diagnoses in 142 histologically proved gastric ulcerative lesions, 120 benign and 22 malignant. The incidence of certain radiographic criteria in the two groups was compared.

2. Mucosal folds which radiate from the edge of the crater were found in 42 per cent of the histologically proved benign ulcers, and in none of the malignant ulcers.

3. Abnormal folds and a filling defect in the region of the ulcer were found in 19 of the 22 histologically proved malignant lesions (86 per cent), and in not over 14 per cent of those proved to be benign.

4. The incidence in the two groups of the following radiographic criteria was not significantly different: penetration beyond the gastric lumen, undermining of the border of the crater, irregular ulcer base, and duodenal ulcer deformity. Other factors of little or no differential value were: location of the ulcer, size of crater, rate of healing, and presence of a normal incisura.

5. The use of histologically proved cases in the analysis of the roentgenograms proved of value in determining which of the criteria that have been used routinely in the past are actually useful in differentiating benign and malignant ulcerative lesions.

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Veterans Administration Hospital
Hines, Ill.

SUMARIO

Úlceras Gástricas Benignas y Malignas: Diferenciación Roentgenológica. Análisis de 142 Casos Comprobados Histológicamente

Este análisis del diagnóstico roentgenológico comprendió 142 lesiones ulcerativas comprobadas histológicamente del estómago: 120 benignas y 22 malignas. Compárase la incidencia de ciertas pautas radiográficas en los dos grupos.

Encontráronse pliegues de mucosa que irradian del borde del cráter en 42 por ciento de las úlceras benignas comprobadas histológicamente, pero no en ninguna de las malignas.

Encontráronse pliegues anómalos y un nicho en la región de la úlcera en 19 de las 22 lesiones malignas comprobadas histológicamente (86 por ciento) y en no más de 14 por ciento de las que resultaron benignas.

No discrepó mayor cosa la incidencia de los siguientes hallazgos radiográficos en los dos grupos: penetración más allá de la luz del estómago, socava del borde del cráter, base irregular de la úlcera y deformidad de úlcera duodenal. Otros factores de poco o ningún valor diferencial fueron: la localización de la úlcera, el tamaño del cráter, la velocidad de la cicatrización y las incisuras normales.

El empleo de casos comprobados histológicamente en el análisis de las radiografías resultó util para determinar cuáles de las pautas usadas sistemáticamente en el pasado son realmente útiles para diferenciar las lesiones ulceradas benignas y malignas en el material presentado.

Intramural Diverticulosis of the Gallbladder[1]

(Rokitansky-Aschoff Sinuses)

WAYNE D. ROSS, M.D., NATHANIEL FINBY, M.D., and JOHN A. EVANS, M.D.

INTRAMURAL diverticulosis of the gallbladder has been described under numerous and varied titles. Rokitansky (1) in 1861 and Aschoff (2) in 1905 studied the mucosal outpouchings in the gallbladder wall and described them as "false diverticula." Halpert (3) in 1927 pointed out the distinction between "true Luschka's ducts" (*i.e.*, aberrant bile ducts not related to the diverticula) and the diverticula which he in turn labeled Rokitansky-Aschoff sinuses. Robertson and Ferguson (4) in 1946 made an extensive pathological study of this condition and surveyed the literature to that time.

Hernia-like protrusions of the gallbladder mucosa through the muscular layer can occur because of the lack of a muscularis mucosa and the loose arrangement of the muscular bundles. This is most likely to occur in the presence of chronic inflammation and increased intraluminal pressure. In their study at the Mayo Clinic, Robertson and Ferguson found 383 cases of cholecystitis; only 33 of these did not exhibit intramural diverticula on pathological study. Of 112 normal gallbladders, 65 failed to show intramural diverticula. The incidence of intramural diverticula was thus 93 per cent for the chronically inflamed and 42 per cent for the normal gallbladders.

Although intramural diverticulosis of the gallbladder is a common pathologic finding, only 11 cases with radiographic demonstration of the diverticula have been reported to date, the first being that of March (5) in 1948. In only 5 cases has an attempt been made to correlate the pathologic and radiographic findings.

CLASSIFICATION

Intramural diverticula of the gallbladder may be of various grades of severity. Robertson and Ferguson presented a classification based on the histologic demonstration of the depth of penetration. A radiographic adaptation of this classification is as follows:

Grade I: The diverticula extend to the muscular layer. This grade is not demonstrated by present radiographic methods.

Grade II: The diverticula penetrate into the intermuscular lacunae and are seen radiographically as fine linear shadows of contrast material adjacent to and paralleling the contrast material in the gallbladder lumen.

Grade III: The diverticula penetrate through the muscular wall into the underlying connective tissue, occasionally reaching the serosa. The radiographic picture is one of an irregular group of rounded densities about the lumen of the gallbladder.

CASE REPORTS

CASE I: A 49-year-old white housewife was admitted to the New York Hospital with a history of intermittent episodes of severe epigastric pain over a period of seven years. The pains were colicky in nature and were often precipitated by fatty foods. Before admission the attacks had become more frequent and severe enough to require bed rest. Physical examination was non-contributory.

Roentgenograms obtained after administration of Telepaque (5 gm.) revealed several small radiolucent calculi in the contrast-filled gallbladder. Surrounding the lumen was a fine rim of opacification. There was a constriction in the region of the gallbladder neck and several small shadows of contrast material were noted in this area (Fig. 1). After the fatty meal the linear shadow about the contracted gallbladder was more clearly defined, and the cystic and common ducts were visualized (Fig. 2).

A cholecystectomy was performed. The gallbladder, containing bile and numerous small black facetted stones, measured 8 × 2 cm. The serosal surface was smooth and glistening, although a few small nodules were noted in the area of the neck.

[1] From the Department of Radiology, The New York Hospital–Cornell Medical Center, New York, N. Y. Accepted for publication in March 1954.

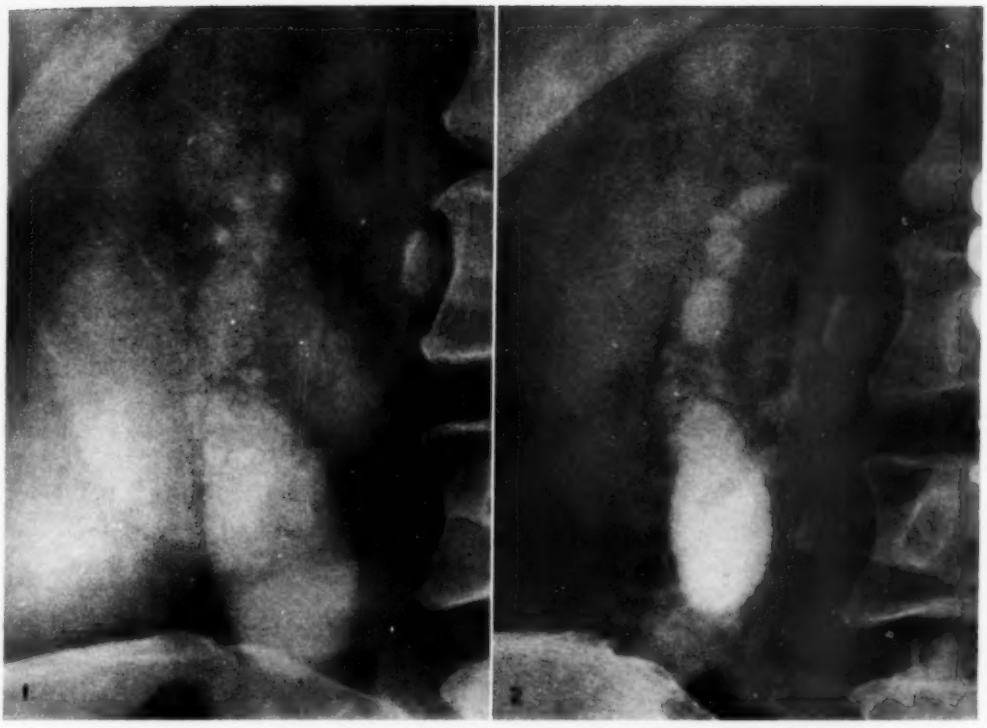

Fig. 1. Case I. Oral cholecystogram demonstrating the concentric ring of contrast material about the gallbladder and small rounded collections of contrast material about the constricted gallbladder neck.
Fig. 2. Case I. After the fatty meal, there is contraction of the gallbladder and better definition of the intramural diverticula. The cystic and common ducts are well visualized; the cholelithiasis only faintly so.

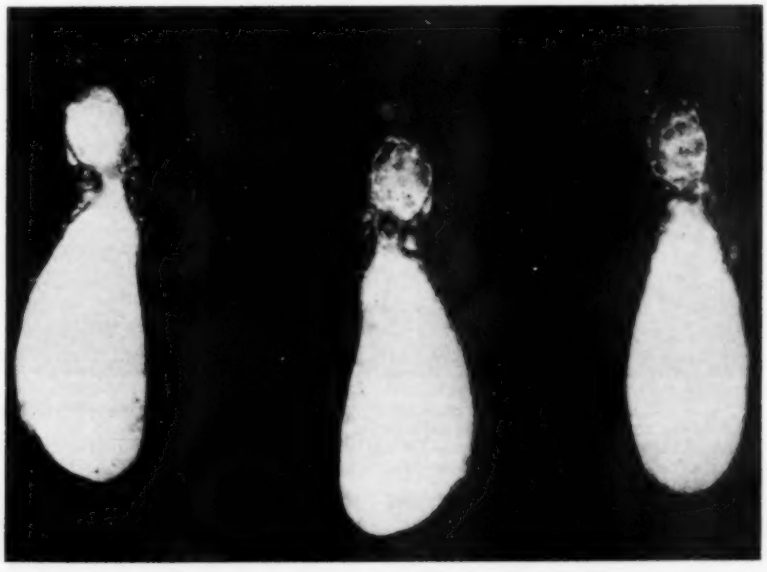

Fig. 3. Case I. Films of contrast-filled specimen demonstrating the intramural diverticula and narrowed segment at the neck of the gallbladder. Incidentally there are a few calculi visible in the cystic duct.

On section the wall measured about 2 mm. in thickness in the region of the fundus, and up to 4 mm. in the region of the neck.

Before sectioning the gallbladder, the cystic duct was tied and the lumen filled with a thin barium mixture. Radiographs of this specimen (Fig. 3) clearly demonstrated the intramural diverticula and the narrowed segment near the neck. Several calculi had been displaced into the cystic duct.

Microscopic examination revealed nests of lymphocytes and moderate fibrous hyperplasia in the muscularis. Numerous diverticula were seen penetrating into the muscularis layer (Figs. 4 and 5).

Case II: A 50-year-old white housewife was admitted to the New York Hospital with a history of postprandial distress for four months and fatty food intolerance for twelve months prior to admission. Physical examination was non-contributory.

Roentgenography after administration of Teleopaque (6 gm.) revealed a septate gallbladder. The distal pouch showed a rim of rounded densities concentrically placed about the periphery of the fundus. Several similar densities were noted in the region of the constriction, approximately 2.5 cm. proximal to the fundus. A similar area of constriction was noted in the neck of the gallbladder. No calculi were

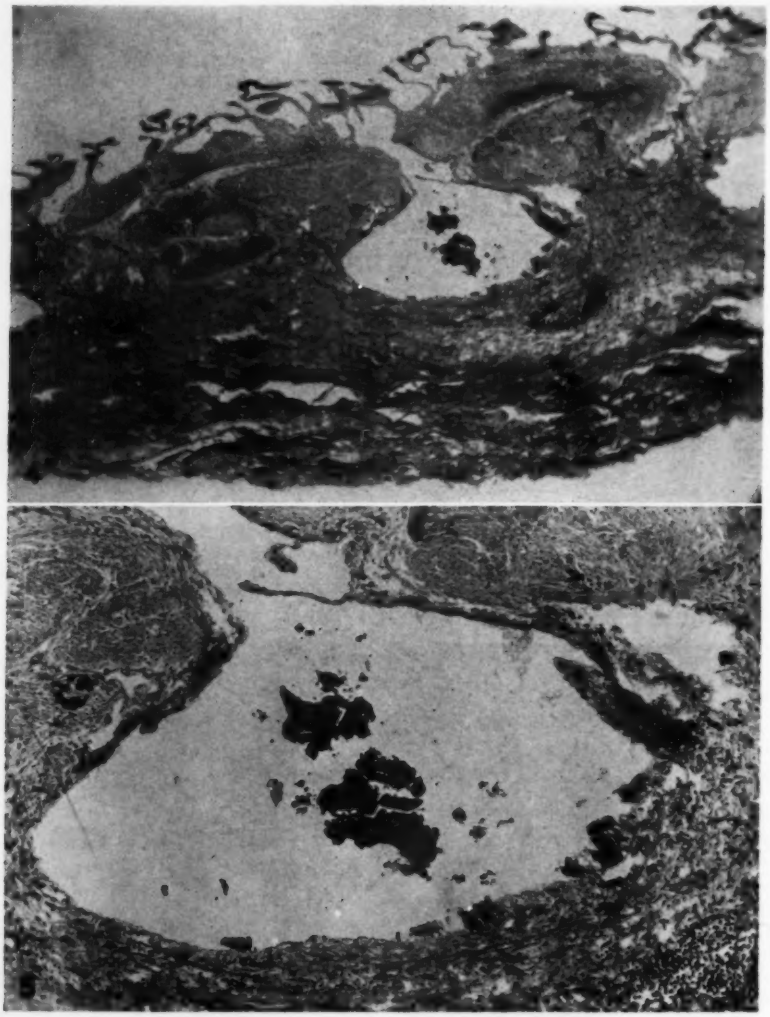

Fig. 4. Case I. Photomicrograph (×30) of a single intramural diverticulum, Grade II, and the connecting duct to the gallbladder lumen.

Fig. 5. Case I. Photomicrograph (×100) of the mucosal lining of the diverticulum and the duct. A portion of a small calculus is noted within the diverticulum.

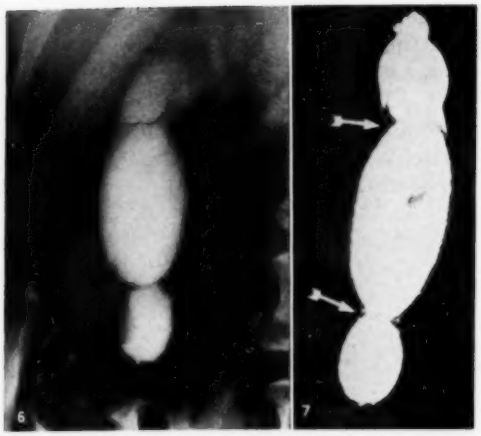

Fig. 6. Case II. Oral cholecystogram demonstrating the constricted areas in the fundus and neck of the gallbladder. The small rounded densities of contrast material about the lumen of the distal segment are clearly demonstrated.

Fig. 7. Case II. Roentgenogram of contrast-filled specimen demonstrating the areas of narrowing (arrows) and the small intramural diverticula in the distal portion of the gallbladder.

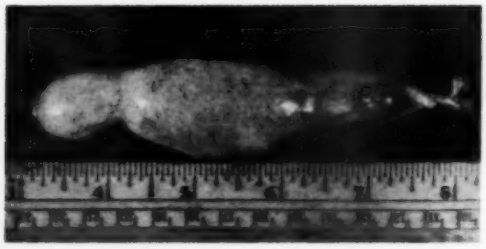

Fig. 8. Case II. Photograph of gallbladder immediately following cholecystectomy. The bladder is unopened and is filled with yellow bile, but contains no calculi. The constricted areas in the fundus and neck are again noted.

evident (Fig. 6). After the fatty meal, there was no essential change in appearance.

A cholecystectomy was performed (Fig. 8). The gallbladder, 13 × 3 cm., was soft and contained bile of normal color. No stones were found. The mucosa appeared normal. Slight thickening of the wall was noted at the sites corresponding to the constricted areas seen roentgenographically.

Roentgenograms of the injected specimen (Fig. 7) showed the intramural diverticula and the narrowed segments of the lumen.

Microscopic examination revealed numerous intramural diverticula (Fig. 9) penetrating into the muscular layer. Mild lymphocytic infiltration was noted.

DISCUSSION

Table I is a compilation of the clinical, radiographic, and pathological findings in the reported cases of radiographic demonstration of intramural gallbladder diverticula.

Clinical Picture: All the cases were examined roentgenographically because of symptoms suggestive of cholecystitis. The chief complaints were right upper quadrant abdominal pain and intolerance to fatty foods. Nine of the 13 patients were women, and the age range was from twenty-two to fifty-seven years. In most cases the history was prolonged, with intermittent attacks. Four of the 13 patients had demonstrable cholelithiasis.

It is felt that the intramural diverticula are related to inflammation and increased pressure within the gallbladder. It is likely, therefore, that the progression of changes from Grade I to Grade III is accompanied by exacerbation of symptoms and the possible complications of acute inflammation, cholelithiasis, and perforation. The visualization of intramural diverticula is therefore an indication for cholecystectomy.

Roentgenography: As expected, there was no case in which Grade I diverticula were apparent radiographically. In 8 cases diverticula of Grade II and in 5 cases diverticula of Grade III were seen. In those cases with pathologic reports the findings were consistent with the x-ray appearance.

In view of the widespread incidence of this condition as noted by histologic examination, it is interesting that so few cases of radiographic demonstration of the diverticula have been reported. Åkerlund and Rudhe (7) point out the factors limiting radiographic visualization of the diverticula. These are: (1) lack of contrast filling of the gallbladder, or low concentration of the contrast medium; (2) diverticula too small, too few, or too shallow to be visualized; (3) lack of contrast because of retained secretion or calculi; occlusion, or narrowing of the duct orifice.

It has frequently been noted that the

diverticula were more clearly demonstrated in the contracted gallbladder following a fatty meal. Their occurrence should be especially suspected when a constriction of the proximal portion of the gallbladder is present.

The recent introduction of new contrast agents, such as Telepaque, and the increasing use of cholangiography may allow more frequent visualization of these diverticula. A recent cholangiogram demonstrated the characteristic picture of Grade II intramural diverticulosis in an acute hydrops of the gallbladder. This case is not reported in detail because pathological confirmation was not obtained.

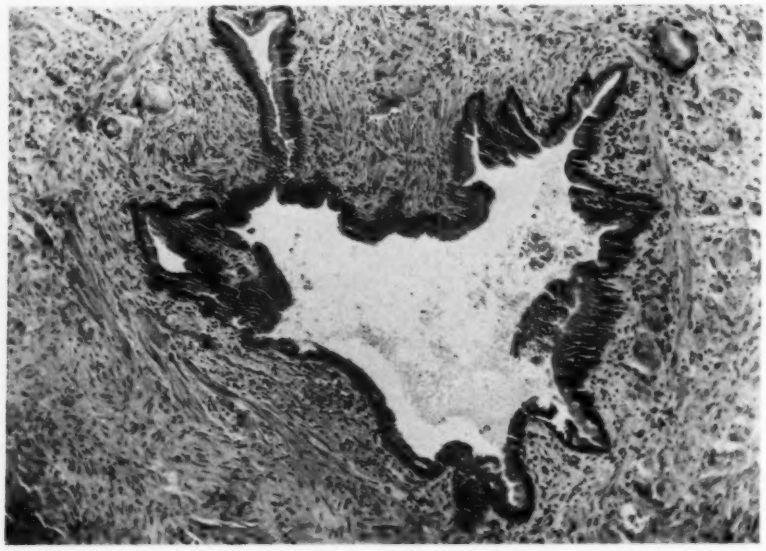

Fig. 9. Case II. Photomicrograph (×30) demonstrating a single intramural diverticulum (Grade II).

Pathology: It is quite apparent that the radiographic visualization of intramural diverticula is an indication of a diseased gallbladder. In 7 of the cases (Cases 1, 3, 4, 8, 10, 12, 13) there was evidence of a constriction in the gallbladder lumen. It is felt that this narrowed segment is responsible for increased pressure within the gallbladder and secondarily for enlargement of the Rokitansky-Aschoff sinuses into demonstrable intramural diverticula. Partial obstruction is possible without demonstration of a narrowed segment, since inflammatory change, thick secretions, or small calculi may obstruct the cystic duct. It is interesting to note that Åkerlund and Rudhe feel that stones in these diverticula may be a factor in the production of cholelithiasis.

In 6 cases (Cases 1, 4, 7, 8, 10, 11) a thick gallbladder wall was found. This is not always associated with Grade III diverticula and is probably a manifestation of the inflammatory process.

Differential Diagnosis: The intramural diverticula are easily differentiated from the solitary true diverticula of the gallbladder. As King (14) has pointed out, Luschka's ducts are really hyperplastic biliary ducts which are present in the subperitoneal layer of the gallbladder and never communicate with the lumen. They are usually seen in young children or infants and are *not* demonstrable by oral cholangiography. Similarly subperitoneal (mesothelial) glands are cyst-like spaces beneath the serosa which have no relation to the gallbladder lumen and *cannot* be visualized cholecystographically.

Occasionally calculi or gaseous material

TABLE I: RADIOGRAPHIC DEMONSTRATION OF INTRAMURAL GALLBLADDER DIVERTICULA

Case and Author	Sex and Age of Patient	Clinical Picture	Radiography	Pathology
1. March (5) 1948	F. 27 years	RUQ pain Cholecystectomy	Concentric rim about lower pouch of a double gallbladder shadow. No calculi	Thick wall with narrow constriction at upper third of gallbladder. No calculi. Diverticula Grade II
2. Ackerman (6) 1948	F.	Not operated	Numerous rounded densities irregularly placed about the lumen. Small calculi	Diverticula, Grade III
3. Åkerlund and Rudhe (7) 1950	F. 52 years	Epigastric pain radiating to right Not operated	Concentric rim about gallbladder. Narrowed neck. No calculi	Diverticula, Grade II
4. Bean and Culver (8) 1950	F. 56 years	RUQ pain Nausea, vomiting, fatty food intolerance Cholecystectomy	Concentric rim of contrast about gallbladder after fatty meal	Thick wall with narrow constriction at neck. Calculi present. Diverticula, Grade II
5. Glücker (9) 1951	F. 57 years	RUQ pain Not operated	Line of dots about gallbladder lumen No calculi	Diverticula, Grade II
6. Zinober (10) 1952	M. 48 years	RUQ pain Cholecystectomy	Concentric rim of contrast about gallbladder; best demonstration after fatty meal	Diverticula, Grade II
7. Lawler (11) 1952	F. 26 years	Upper abdominal pain Cholecystectomy	Rounded densities at margin of gallbladder No calculi	Diverticula, Grade III. Thickened gallbladder
8. Sukman and Daron (12) 1953	M. 22 years	RUQ pain Fatty food intolerance Cholecystectomy	Rounded densities of contrast in large diverticula about gallbladder No calculi	Diverticula, Grade III. Thick walled gallbladder with narrowed mid portion
9. Lapointe (13) 1953	M. 40 years	Epigastric pain Cholecystectomy	Rounded densities of contrast about gallbladder lumen. Calculi	Diverticula, Grade III
10. King (15) 1953	F. 35 years	RUQ pain Fatty food intolerance Cholecystectomy	Small rounded densities in concentric rim about lower pouch of a double gallbladder shadow. Calculi present	Thick wall with narrow constriction at upper third of gallbladder. Calculi. Diverticula, Grade II
11. King (15) 1953	M. 41 years	RUQ pain Mild diarrhea Cholecystectomy	Concentric rim of contrast surrounding gallbladder lumen	Thick-walled gallbladder. Calculi present. Diverticula, Grade II
12. Ross, Finby and Evans 1953	F. 49 years	Epigastric pain Fatty food intolerance Cholecystectomy	Concentric rim of contrast surrounding gallbladder lumen. Calculi	Narrowed neck of gallbladder. Calculi. Diverticula, Grade II
13. Ross, Finby and Evans 1953	F. 50 years	Postprandial distress Fatty food intolerance Cholecystectomy	Small rounded densities in concentric rim about periphery of fundus. No calculi	Narrowing in neck and fundus. Diverticula, Grade II and III

is present in the intramural diverticula. In these cases diagnostic shadows may appear outside the gallbladder lumen.

SUMMARY

1. Two new cases with radiographic demonstration of intramural diverticula of the gallbladder are presented. Eleven cases were found on a review of the literature.

2. Intramural diverticula of the gallbladder are associated with inflammatory disease and cholelithiasis. Their radiographic visualization is an indication for cholecystectomy.

3. Of 13 cases, 50 per cent showed a narrowed luminal segment; in 30 per cent there was evidence of calculi; 75 per cent occurred in women. All were associated with symptoms suggestive of cholecystitis.

4. It is anticipated that newer contrast agents for cholecystography may allow more frequent radiographic demonstration of this condition.

5. A radiographic adaptation of the pathological classification is presented.

NOTE: We are indebted to Dr. John E. Sutton, Jr., Assistant Attending Surgeon, The New York Hospital, for permission to use Case II.

ADDENDUM: Since this paper was submitted for publication we have seen an additional 5 cases of intramural diverticulosis of the gallbladder demonstrated on cholecystography.

525 E. 68th St.
New York 21, N. Y.

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SUMARIO

Diverticulosis Intramural de la Vesícula Biliar

Preséntanse 2 casos de divertículos intramurales de la vesícula biliar (senos de Rokitansky-Aschoff), que fueron descubiertos roentgenográficamente. En la literatura se encontraron otros 11 casos, tabulándose aquí los 13. La dolencia va unida a enfermedad inflamatoria y colelitiasis, y su descubrimiento constituye una indicación para la colecistectomía.

La siguiente clasificación se basa en la correlación de los hallazgos radiológicos e histopatológicos:

Grado I: Los divertículos se extienden a la capa muscular. Este grado no se descubre con los actuales métodos radiográficos.

Grado II: Los divertículos penetran en las lagunas intermusculares y se observan radiográficamente en forma de finas sombras lineales de la substancia de contraste, adyacentes y paralelas a la substancia de contraste que se halla en la luz de la vesícula biliar.

Grado III: Los divertículos penetran a través de la pared muscular al tejido conjuntivo subyacente, llegando de vez en cuando a la serosa. El cuadro radiográfico muestra un grupo irregular de condensaciones redondeadas alrededor de la luz de la vesícula biliar.

De la serie de 13 casos en que se hicieron estudios roentgenológicos, 7 revelaron un segmento luminal estrechado; 5 estaban asociados con cálculos; 9 fueron en mujeres. En todos, los síntomas eran indicativos de colecistitis.

Comparative Survival Times of X-Ray Treated Versus P^{32} Treated Patients with Chronic Leukemias Under the Program of Titrated, Regularly Spaced Total-Body Irradiation[1]

EDWIN E. OSGOOD, M.D., ARTHUR J. SEAMAN, M.D., and HAROLD TIVEY, M.D.
With the technical assistance of Charlotte A. Moffat, M.T., and Margret E. Hughes, M.T.

In the period from January 1941 to July 1951, treatment of 163 patients with chronic leukemia by the method of titrated, regularly spaced total-body irradiation (1, 2) was started. The basic principles of treatment were identical for all of these patients, but some were given spray roentgen irradiation and others internal irradiation by intravenously injected radioactive phosphorus (P^{32}). No difference between the clinical response to x-ray irradiation and to P^{32} was noted. A comparison was made of the survival times of the two groups to determine if spray irradiation by x-rays offers a better prognosis than equivalent internal irradiation by radioactive phosphorus.

Leukemia is a completely disseminated neoplasm, with infiltration of all organs and tissues. It has repeatedly been observed that the feeling of well-being of the patient with this disease is maximal when leukocytosis, hepatomegaly, splenomegaly, anemia, and lymphadenopathy are minimal. To reach all neoplastic cells, total-body irradiation should be administered at such intervals as are necessary to keep the leukemic cell population within optimal limits.

In the small doses used in this study radiation acts primarily on leukemic cells by inhibiting mitosis in the granulocytic series, but it may be capable of killing lymphocytes, as well as interfering with their proliferation (3). The life span is approximately five days for cells of the granulocytic series and something in excess of thirty days for the lymphocytes of *chronic* leukemia (4). Small alterations in the mitotic rate can rapidly change the total mass of leukemic cells in a few generations. Such changes will be most evident in the patient with a large number of leukemic cells initially present. It therefore becomes desirable to follow chronic leukemia patients at intervals consistent with the short life span of these cells to prevent the possibility of massive leukemic cell overgrowth.

The margin between doses of total-body irradiation suppressing the leukemic process and those depressing erythropoiesis is sometimes small. Since leukemic infiltration of all available marrow spaces and/or a hemolytic process frequently predisposes toward anemia, considerable caution in radiation dosage is indicated (5). The patient's most probable prognosis for total survival, 2.65 years by the usual method of treatment (6), is so modified by a skewed distribution of survival times that the recorded survivals in excess of twenty years (7) are predictable events. Unfortunately, there is no reported basis for determining those patients who are destined to have an unusually long survival (8). It then becomes evident that the smallest effective doses of radiation are least likely to produce depression of erythropoiesis or to effect over this long period a mutagenic change leading to carcinoma or other fatal complications.[2]

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[1] From the Division of Experimental Medicine, Department of Medicine, University of Oregon Medical School, Portland, Ore. Supported in part by grants-in-aid from the Division of Biology and Medicine of the U. S. Atomic Energy Commission, The National Cancer Institute of the United States Public Health Service, and the Medical Research Foundation of Oregon. The radioactive phosphorus used in this investigation was supplied by Clinton Laboratories, Knoxville, Tenn., and by Union Carbide and Carbon Corporation, Oak Ridge, Tenn., on authorization from the Isotopes Division, U. S. Atomic Energy Commission.
Presented at the Thirty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 13–18, 1953.

[2] For footnote, see page 375.

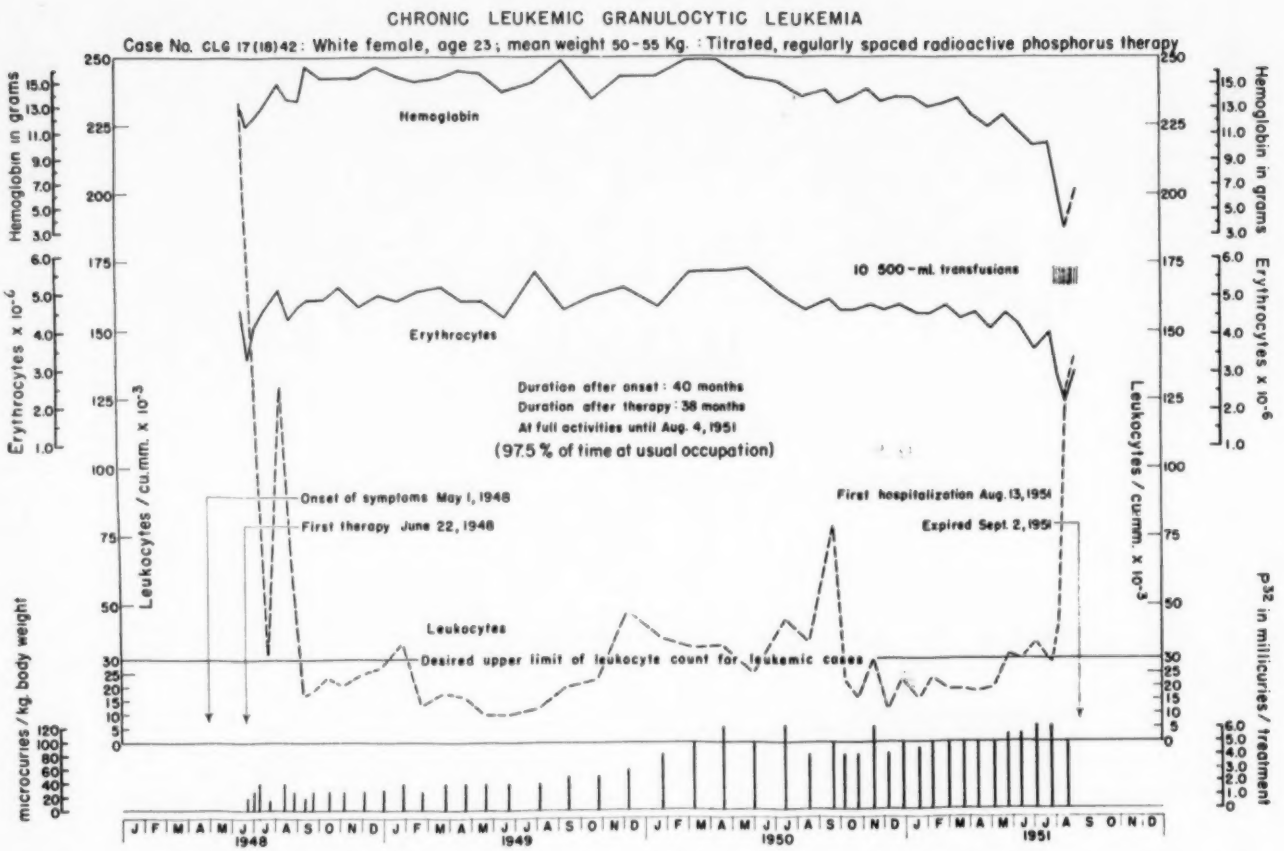
CHRONIC LEUKEMIC GRANULOCYTIC LEUKEMIA
Case No. CLG 17(18)42: White female, age 23; mean weight 50-55 Kg. : Titrated, regularly spaced radioactive phosphorus therapy
Hemoglobin in grams
Erythrocytes x 10⁻⁶
Leukocytes / cu.mm. x 10⁻³
microcuries / kg. body weight
P32 in millicuries / treatment
Hemoglobin
Erythrocytes
Leukocytes
10 500-ml. transfusions
Duration after onset: 40 months
Duration after therapy: 38 months
At full activities until Aug. 4, 1951
(97.5 % of time at usual occupation)
Onset of symptoms May 1, 1948
First therapy June 22, 1948
First hospitalization Aug. 13, 1951
Expired Sept. 2, 1951
Desired upper limit of leukocyte count for leukemic cases
1948
1949
1950
1951

Fig. 1. Course of a case of chronic leukemic granulocytic leukemia, with unusual difficulty in titration. This illustrates the changes in dose and interval that are sometimes necessary with either radioactive phosphorus or x-ray therapy.

TABLE I: TYPICAL (MEDIAN) TOTAL RADIATION REQUIREMENTS FOR PATIENTS WITH CHRONIC LEUKEMIA

	Granulocytic		Lymphocytic	
	P^{32}	X-ray	P^{32}	X-ray
For Control:				
r or μc./kg. P^{32} radiation given in this number of treatments	160 5	160 9	90 4	90 6
To Maintain Control:				
r or μc./kg. P^{32} per year given in this number of treatments per year	230 7	350 17	100 5	130 7

Radiation "to control" is progressively spaced over a period of about six to twelve weeks. Radiation "to maintain" characteristically is regularly spaced over the year. This is not a guide to therapy. See text.

Since associated diseases and complications account for an appreciable proportion of morbidity and mortality in the chronic leukemias (2), some one person should accept overall responsibility for the management of all the patient's problems from diagnosis to death. One of the more common problems, an acquired hemolytic anemia, is not limited to lymphocytic leukemias, but occurs also in both a latent and manifest form in granulocytic leukemia (11).

On the basis of the foregoing fundamental considerations, the principles of treatment by the method of titrated, regularly spaced total-body irradiation are:

(*a*) To bring the patient's disease under initial control by small doses (*ca.* 10 to 20 r or equivalent P^{32}) at intervals of one or two weeks.

(*b*) To maintain that control by minimal doses (10 to 20 r) at such appropriate regular intervals that the patient *remains* in an optimum state of health. Dosage based upon the patient's total previous response is given to prevent the leukemic process from going out of control just as the highly individualized insulin requirements of a diabetic are repeated to maintain his ideal status.

(*c*) Most important, to adjust the treatment to fit the needs of the individual, *i.e.*, *titrate* the amount of radiation given against the clinical condition. One must not treat the leukocyte count, but the entire patient. Most patients with leukemic leukemias will feel best with leukocyte counts below 25,000 per c. mm. and above 10,000 per c. mm., but rarely one may be in optimal condition with a leukocyte count as low as 5,000 or as high as 50,000. Further essential details of this program of therapy have been previously reported (1, 2).

The details of the variability of dosage and interval used in the treatment of this disease are the subject of a separate report (12). These can best be summarized by stating that any inflexible radiation schedule would probably be ineffective in at least one-third of all patients and prove definitely harmful to at least an additional third. The continuing adjustment of the treatment to the individual's needs is the most important single aspect of this method of management. With these reservations, typical values of dosage and interval are given in Table I. The clinical course of a patient treated by this method is shown in Figure 1.

The patients studied include all who were referred for treatment, even those moribund at the first visit. No patients have been lost to follow-up. Details on age, sex, and clinical characteristics of these patients have been previously presented (2).

We believe this series of patients to be representative of similar groups seen at university hospitals in other parts of the country. As far as we can determine, there is only one factor which might have influenced the selection of patients referred. When radioactive phosphorus first became available, a few unusually difficult cases may have been referred on

[2] The problem of radiation-induced mutations in patients with leukemia is of more than academic interest. In this series, 4 patients have died with a blood picture suggestive of an *acute* leukemia of *another cell type* (9). If confirmed, such changes might be attributed to the mutagenic effects of the radiation used to treat the patient's chronic leukemia. Hall (10) reported 4 cases of *acute* leukemia in 124 polycythemia vera patients treated with P^{32}. Among 90 cases of polycythemia vera treated with P^{32} during a comparable period in this Division, one definitely and a second possibly terminated in acute leukemia.

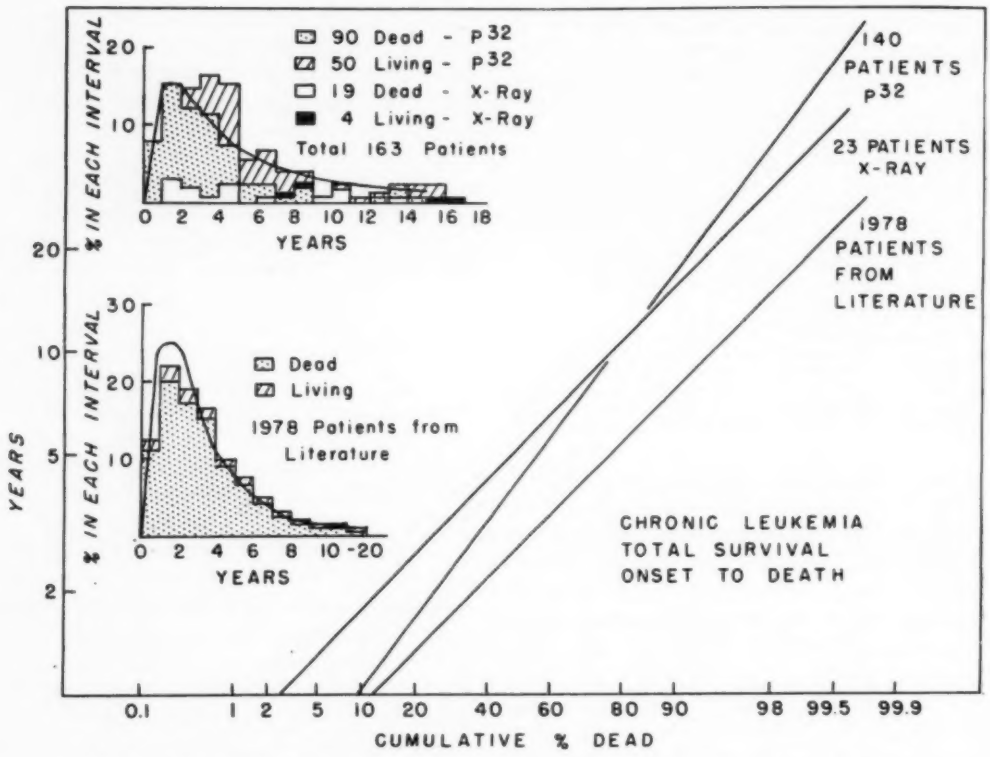

Fig. 2. Distribution of comparative survival times from onset of symptoms to death of x-ray and P^{32} treated patients with chronic leukemia. The curve superimposed on the upper histogram of the actual data represents both the x-ray and P^{32} treated cases.

the premise that P^{32} represented a new "wonder drug." We have attempted to minimize this possible source of error by larger numbers of patients in the P^{32} treated group. In all other respects we feel the x-ray and P^{32} groups are essentially identical.

Factors used in roentgen irradiation were 220 kv; 0.5 mm. Cu +1.0 mm. Al filter to give h.v.l. 1.1 mm. Cu; 60–100 cm. target-skin distance; rate, 11 r per minute. Two ports were used at each visit, the entire upper and lower halves of the body. Successive treatments were alternated front and back. Dosages were measured in air at skin level and do not include back-scatter; "10 r" means 10 r to *each* of the upper and lower ports.

It has been previously demonstrated that the logarithms of survival time in patients with chronic (6) (and acute) (13) leukemia follow normal distributions. D. E. Lea has devised a method of predicting the ultimate outcome of such a log-normal distribution of survival times before all of the patients are dead (14). The data given are the *predicted* median (logarithmic mean) survival times for the various groups studied. Significance of differences was calculated in the usual fashion, with use of the logarithmic means and standard deviations derived from Lea's methods of calculation.

We have previously shown that delay to treatment and the survival after treatment may also be represented by log-normal distributions. It has been further demonstrated that there is little correlation between the duration of symptoms before therapy and survival after therapy. The median total survival of these patients is not the sum of the median survival after

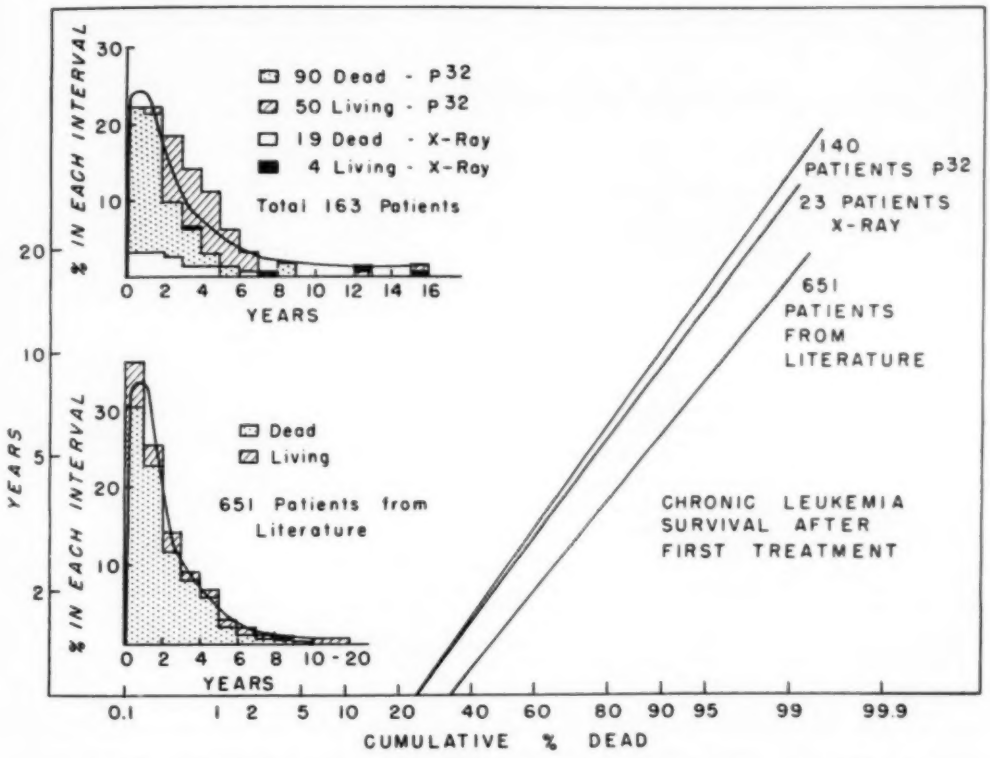

Fig. 3. Distribution of comparative survival times from first treatment to death of x-ray and P^{32} treated patients with chronic leukemia. The curve superimposed on the upper histogram of the actual data represents both the x-ray and P^{32} treated cases.

therapy and the median delay to therapy but will be represented by a somewhat larger figure than this sum (6).

RESULTS

In Figures 2 and 3 we have shown the distributions of total survival time and survival after therapy of the 23 x-ray treated patients, 140 P^{32} treated patients, and the corresponding distributions of survival time in leukemia taken from a review of the literature. Results for lymphocytic and granulocytic leukemia are combined, since no difference in prognosis is discernible (6). The parameters of the various distributions and the significance of differences between the median survival times are given in Table II. Successive predictions of the outcome of this series are given in Table III.

DISCUSSION

Reference to Table I will show that the differences in total survival time between those patients treated with spray roentgen irradiation and those treated with P^{32} are no greater than could be expected on the basis of chance alone 16 times out of 100 if additional series with similar numbers of patients in each group were studied. The difference between median survival times after therapy could arise on the basis of chance alone in 38 trials of 100. On the basis of this study, therefore, the prognosis for survival will be no different whether the patient receives total-body irradiation externally by the spray technic or internally by radioactive phosphorus.

The observed equal effectiveness of these two methods of delivering ionizing radiation to the patient is to be anticipated as

TABLE II: COMPARISON OF SURVIVAL OF PATIENTS TREATED BY SPRAY ROENTGEN IRRADIATION AND P^{32}

Item	No. Patients	Treatment	Median Survival*	95 per cent Confidence† Limits	10 per cent Live‡ Longer Than	Probability of§ Chance Difference (%)	Between Items
		Years Total Survival					
1	23	Spray roentgen therapy: present series	5.2	3.5–7.5	15	<1	1, 4
						16	1, 2
2	140	P^{32}: present series	4.2	3.6–5.0	17	<1	2, 4
3	163	Both: present series	4.2	3.5–5.0	17	<1	3, 4
4	1,978	Roentgen therapy: cases from literatures (8)	2.65	2.55–2.75	7.8		
		Years Survival After Therapy					
5	23	Spray roentgen therapy	2.2	1.8–2.7	8.8	<1	5, 8
						38	5, 6
6	140	P^{32}	2.3	1.9–2.8	10	<1	6, 8
7	163	Both	2.3	1.9–2.7	9.7	<1	7, 8
8	651	Roentgen therapy: cases from literature (8)	1.56	1.44–1.70	5.7		
		Years Delay to Therapy					
9	23	Spray roentgen therapy	1.3	0.8–2.2	6.0	~1	9, 10
10	140	P^{32}	0.7	0.6–0.9	3.5		
11	163	Both	0.8	0.6–0.84	3.9		
12	...	No comparable data from literature					

* These are log-normal distributions, and at the median survival 50 per cent of the patients are dead. "Average" survival times would be much higher than the median but are not representative of this type of skewed distribution.

† A series of the size shown would have median values within the limits given in 95 of 100 trials.

‡ The skewness of the distribution is emphasized by these values.

§ The probability that differences of medians as large as those seen could arise by chance alone.

long as the method of treatment is the same. It may be noted that the results of the regularly spaced, titrated, whole-body irradiation technic are superior to those for a series of cases of leukemia treated by conventional methods which were assembled from the literature (6). It is possible that this "control series" from the literature does not represent present-day radiologic practice, but no more modern data are available for comparison.

Since the conclusions of this report are based upon comparisons of series of patients in which some are still living, one may legitimately question the reliability of prediction. It should be pointed out that the method of calculation gives the observations on the living a lesser importance than those on the dead patients. All such uncertainties are reflected in the fairly large confidence limits attached to each of the median survival times. Boag has made an elegant extension of this method of prediction to the problem of calculation of absolute cure rates in patients treated for carcinoma (15). He has found that predictions based upon an analogous method of computation are extremely reliable. A series of successive predictions of the outcome of this series is shown in Table III. It will be noted that there is no greater variation in the predicted outcome of this series than would be anticipated on the basis of chance alone. The agreement between predicted and observed median values is excellent.

For the internist, the use of radioactive phosphorus is more convenient than the use of spray roentgen irradiation. For the radiologist, there is probably little to recommend one method of treatment over the other. No radiation sickness has been encountered with either type of therapy in the usual dosage range. On the basis of the evidence at hand, the patient can be equally well treated by either. The principal contribution that this study can make is to dispel some of the "magic aura" which, in the minds of some physicians, surrounds the clinical use of radioactive isotopes.

TABLE III: SUCCESSIVE PREDICTIONS OF MEDIAN TOTAL SURVIVAL TIME IN PATIENTS OF THIS SERIES

Patients	Composition	Predicted Median Survival Time (in Years) and [Confidence Limits]				Observed Survival Time of Median Dead Patient (July 1953)
		July 1950	July 1951	January 1952	July 1953	
58	All seen January 1941–December 1949	4.4 [3.1–6.1]	4.8 [3.4–6.9]		5.0 [3.6–7.0]	4.7
	Per cent living	55	50		43	
117	All followed 2 years by January 1952	...	...	4.1 [3.3–5.0]	4.2 [3.5–5.1]	4.4
	Per cent living			37	30	
163	All seen January 1941–July 1951	...	...	4.1 [3.4–5.0]	4.2 [3.5–5.0]	4.3
	Per cent living			39	33	

Note that there has been no change in the predicted values greater than that expected from chance alone over a period of three years. The first two groups of 58 and 117 patients are sub-groups of the third group.

SUMMARY

A study was made of the survival times of 163 patients with chronic leukemias by the method of titrated, regularly spaced total-body irradiation. Twenty-three received spray roentgen irradiation; 140 were given P^{32}.

The prognosis for survival was not significantly different whether the total-body irradiation was delivered externally by the spray technic or internally from radioactive phosphorus, provided all other conditions of treatment were identical.

The prognosis for survival of patients with leukemia treated by titrated, regularly spaced total-body irradiation, either with the spray technic or P^{32}, is significantly better than that for a collected series including all radiation treated cases reported in the literature in the interval 1925 to 1951.

ACKNOWLEDGMENT: Drs. Wallace Haworth, G. B. Isenhart, J. Richard Raines, and C. T. Jessell of Portland, Ore., administered the spray irradiation given most of the patients in this series in accordance with dosage and intervals prescribed by the authors. Without the careful and considerate cooperation of these radiologists, and others, this study would have been impossible.

3181 S. W. Sam Jackson Park Road
Portland, Ore.

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SUMARIO

Tiempos Comparados de Sobrevivencia de los Leucémicos Crónicos Tratados con los Rayos X y los Tratados con P^{32} Conforme al Plan de Irradiación Espaciada Regularmente y Titulada de Todo el Cuerpo

Este estudio versó sobre los tiempos de sobrevivencia de 163 enfermos que tenían leucemia crónica y fueron tratados con la técnica de irradiación titulada y espaciada regularmente de todo el cuerpo. Veintitrés recibieron irradiación roentgen dispersa; a 140 se les administró P^{32}.

El pronóstico en cuanto a sobrevivencia no varió mayor cosa, ya se entregara la irradiación total del cuerpo externamente con la técnica dispersa o internamente con P^{32} siempre que fueran idénticas las demás condiciones del tratamiento.

El pronóstico en cuanto a sobrevivencia de los leucémicos tratados con la irradiación titulada y espaciada regularmente de todo el cuerpo, ya con la técnica dispersa o el P^{32}, fué significativamente mejor que el obtenido en una serie compilada que comprende todos los casos tratados con la irradiación descritos en la literatura en el período de 1925 a 1951.

DISCUSSION

Theodore P. Eberhard, M.D. (Philadelphia, Penna.): It is unfortunate with the short period of five minutes available to me that Dr. Osgood and Dr. Tivey have given us three papers in one. We have one portion of this paper dealing with the principles of treatment, one portion dealing with the relative results of P^{32} versus total-body x-ray therapy, and a third part consisting of a most beautiful demonstration of how we all ought to present our statistics and analyze our results.

So far as the relative value of P^{32} and spray radiation is concerned, like Dr. Tivey, I am not at all surprised that the two came out together. They are both forms of total-body ionizing radiation and hence should, if properly handled, give essentially the same results. The essayists are certainly to be congratulated on having done such a beautiful piece of work in proving that our anticipated conclusions were correct.

In regard to the principles of treatment, however, I think there is room for discussion. It is implied in this paper, as well as in other publications by Dr. Osgood, that the results can be attributed to what is called titration, regular spacing, and total-body exposure. Let us take these three up separately.

In the first place, I object personally to the essayists' use of the word "titration." I believe the dictionary defines titration as a volumetric method of determining concentration. As used here, it simply means adjusting dosage to the individual patient. Most of us do that. I doubt if there is anybody in this room today who goes up to a leukemic patient he has never seen before and blasts him with 200 r, and to heck with it! It is essential, as we all know, that we approach these patients cautiously with small doses and determine their individual reactions. The tolerance limits vary tremendously from one to another. It is most important to avoid overdose.

Second is the matter of regular spacing. It is observed on Dr. Osgood's own chart that the treatments are not regularly spaced. They are regularly spaced to a certain extent during the asymptomatic periods, but the rest of the time they are varied, just as the rest of us vary our treatments. We come here to a matter of philosophy, particularly in regard to chronic lymphatic leukemia. The principle of treatment in the Osgood group is that every patient, when he is first seen, should receive treatment immediately. The approach of our group differs from this. We feel that a great many of the chronic lymphatic leukemia patients are actually asymptomatic. Many of them are discovered on routine blood counts for some totally different cause.

I picked out of our group of 75 cases treated since 1943, a couple of days before I came out here, 7 of chronic lymphatic leukemia that we have been following from four to nine years. None of these patients has ever received any irradiation; when required, they receive TEM, nitrogen mustard, and high vitamin therapy. They carry counts anywhere from 20,000 to 200,000; they are quite happy; and they, too, have continued at their work for 97

per cent of their useful lives. So I think there are many patients who do not require continuous treatment. There are a few that do not require any suppressive therapy.

I think, as Dr. Tivey suggested, that one of the reasons for the apparent great improvement in this series as compared with the series which was chosen for control is the greater use of antibiotics to control infection—which was the bugbear of the leukemia patient—the greater use of transfusions, the greater realization of the importance of high vitamin therapy (particularly vitamin B complex) and a high-protein diet. It is remarkable in how many of these patients the blood count will fall and node masses disappear under no treatment except massive doses of brewer's yeast and a high protein intake. Furthermore, as Dr. Tivey suggested, we must consider the possible mutagenic effects. I am sure all of us have seen these rather disturbing and peculiar instances of development of a new type of leukemia long years after chronic exposure to radiation and similar agents.

Then we come to the problem of total-body exposure. Is it wise? Is there only a direct ionizing effect on the individual leukemic cell, or may there not be some photochemical associated effect? We are all familiar with the fact that most of us treat a very small part of the body and the lumps, if they are present, will frequently subside with the count, suggesting that perhaps it is not necessary to expose the entire body, and I think it does carry in the long term perhaps more hazard than more localized radiation. Of course, we are on the defensive because Dr. Osgood and Dr. Tivey have produced a beautiful series, beautifully controlled and beautifully analyzed, and the rest of us have not.

One thing that has impressed me is the great importance of maintaining these patients under the control of one individual. The patient, if passed around from internist to hematologist, to radiologist, working individually, is always going to suffer. He must be treated as an individual and as a total individual. He must not be treated by the book. He must be treated according to the way he responds and according to his individual requirements.

And finally, again I want to emphasize and call to the attention of all of you the beautiful analytical work of Dr. Tivey. I understand that he is now engaged on the monumental task of trying to take this very involved statistical method, which only a fellow like himself can handle, and reduce it to terms that you and I can take care of.

R. R. Newell, M.D. (San Francisco, Calif.): Dr. Tivey has shown what one can do for leukemia patients under one philosophy, or school of therapy, well persisted in. It turns out that the patients did equally well with x-rays and with P^{32}. What I want to point out is that both groups were under the same skillful handling. If a radiologist is administering the therapy, success will come according to his skill as a physician, not just by his skill in applying the radiation. Patients treated with P^{32} are some of them likely to be continuously under the care of an internist or hematologist. It remains to be seen whether such a specialist will average more skillful than radiologists in the past. The physical measurements and technics are no longer a dominant consideration. It is good to have Dr. Tivey's reassurance that we can do as adequate a job with one agent as with the other: P^{32} or total body x-ray therapy.

I'm glad to hear Dr. Eberhard speak for the patient's own powers of controlling his leukemic processes for long periods of time.

Harold Tivey, M.D. (*closing*): I want to thank Dr. Eberhard for his kind words. I have not clinical experience to evaluate the relative merits of these two types of treatment. I think that question will ultimately be answered when the experiences of the groups who utilize them are published further in detail.

In regard to the effects of antibiotics and other adjuncts, we have no method of separating these effects from those of other modes of treatment.

I should like to express my appreciation to the Society for the privilege of attending this meeting and presenting this paper. I am sure that I have learned a great deal more from this discussion and from numerous other discussions about the treatment of leukemia than we have been able to contribute.

Changes in the Human Leukocyte Count During X-Ray Therapy for Cancer and Their Dependence Upon the Integral Dose[1]

HENRY I. KOHN, Ph.D., M.D.

THAT X-RAYS depress the leukocyte count is well known, but the dependence of this phenomenon upon the dose rate, the tissue dose, the integral dose, and the kind of tissue irradiated has not been fully analyzed.

The gross changes in the cell counts of patients receiving fractionated treatment for various types of malignant growth were described by Gloor and Zuppinger (10) and Schmitz (27), and in more detail by Kornblum, Boerner, and Henderson (15, 16). Consistent changes in the basophils, eosinophils, and monocytes were not observed. The neutrophils rarely fell below 2,500, but the lymphocyte count frequently declined to the range of 500–1,000. Kornblum *et al.* (15) noted that irradiation of the head and neck tended to produce smaller changes in the counts than irradiation of the trunk, where larger fields were employed. All cell counts returned to approximately normal levels at about five weeks after treatment. Schmitz commented that in twenty-three years of experience with 6,000 patients he had seen only one case of fatal leukopenia, which occurred in a woman taking amidopyrine.

The quantitative relationship between change in lymphocyte count and integral dose has been examined in two studies: Bush (3) reported the average lymphocyte count in 26 cases during treatment to the head and neck, and Price (25) made a similar study of 16 patients receiving irradiation to the pelvis and lower abdomen. The data of these investigators are shown in Figure 1 and may be used to emphasize several questions. The rate of fall in the lymphocyte count differed considerably in the two series. Was this due to the difference in integral dose, in integral dose rate, or local tissue factors? Also to be explained is the mechanism by means of which partial-body irradiation, for example limited to the neck, can disturb the function of a system as widely dispersed as the lymphatic.

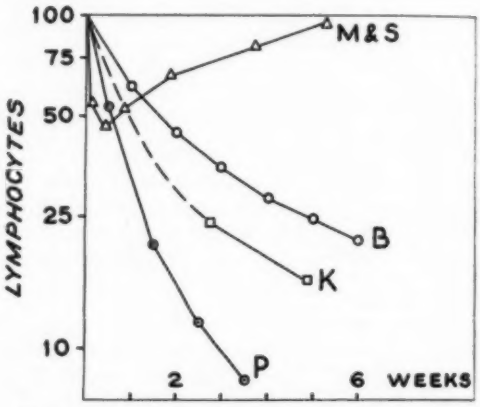

Fig. 1. Relative lymphocyte count (initial count = 100 per cent) during treatment. *Curve B* (Bush): Group 11, 0.13 megagram-r/day to the neck and pharynx. *Curve K:* Group 1*a*, 0.91 megagram-r/day to the pelvis. *Curve P* (Price): Group 2, 1.86 megagram-r/day to the pelvis. *Curve M & S* (Minot and Spurling): 19 patients treated intensively to the thorax and abdomen for only one to four days; dose rate not known.

METHODS

X-Ray Dosage: The term tumor dose refers to the average tissue dose absorbed in the region of the tumor. Mayneord (19) introduced the term *integral dose* to specify all of the radiation absorbed within the body. A similar basic concept underlies the term *volume dose*, used by Ellis (8).

[1] From the Radiological Laboratory, Department of Radiology, University of California School of Medicine, San Francisco, Calif., and the National Cancer Institute, National Institutes of Health, Public Health Service, Department of Health, Education, and Welfare. The Radiological Laboratory is one of the research and development installations of the U. S. Atomic Energy Commission.
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TABLE I: INTEGRAL DOSE IN GRAM-ROENTGENS PER ROENTGEN TO THE SKIN
(Calculated from Water Phantom Data in Supplement No. 5, British Journal of Radiology*)

Field Size (cm.²)	Depth (cm.) 2	7	12	17	22	32	52
h.v.l. = 1 mm. Cu; T.S.D. = 50 cm.; closed-end applicator							
50	97	281	377	432	460	484	491
100	194	576	790	916	988	1,070	1,080
150	302	900	1,250	1,470	1,590	1,710	1,750
200	402	1,220	1,700	2,000	2,170	2,370	2,400
400	831	2,550	3,670	4,430	4,910	5,410	5,680
h.v.l. = 4 mm. Cu; T.S.D. = 70 cm.; open port							
50	100	285	389	449	482	510	521
100	200	594	826	978	1,060	1,130	1,160
150	300	903	1,260	1,490	1,640	1,720	1,770
200	420	1,250	1,780	2,100	2,300	2,500	2,600
400	840	2,640	3,750	4,560	5,040	5,550	5,850

* For h.v.l. = 2 mm. Cu and T.S.D. = 70 cm., open port, an adequate approximation is obtained by multiplying the values in the table for h.v.l. = 1 mm. Cu and T.S.D. = 50 cm. by 1.04.

Mayneord and Ellis have argued that, while the *tumor dose* may be the decisive factor in determining the chance of cure, the integral dose may be the decisive factor in determining the systemic reaction to a course of therapy. *Specific integral dose*, a new term, is introduced below; it is defined as integral dose per kilogram of body weight.

The integral dose is the product of *mean tissue dose in roentgens* times *total grams of tissue*, the basic unit being the gram-roentgen (gram-r). The megagram-r is equivalent to about 2 calories. The integral dose was estimated by applying the basic principles discussed by Mayneord (19, 20), and also by Happey (12), and is considered to be a useful relative measure. As calculated below, it does not allow for radiation scattered beyond the geometrical definition of the beam. Such outlying areas may receive a dose in roentgens averaging perhaps 5 per cent of the dose to the skin at the field of entry. Because of the large volume of tissue which may be involved, the possible contribution to the integral dose from this source may be considerable (5). Whether or not the integral dose due to a small tissue dose affecting a large mass is physiologically equivalent to a large tissue dose affecting a small mass is not known.

X-ray treatments were given five or six times a week in the Radiation Therapy Clinic of the University of California Hospital, usually at the same hour of the day. Three technics were employed. The majority of patients were irradiated with a beam of 1 mm. Cu half-value layer (h.v.l.) from a 200-kvp unit at 50 cm. target-skin distance (T.S.D.). The rest were treated with the beam from a 400-kvp unit at 70 cm. T.S.D., filtered to a h.v.l. of either 2.4 or 4.1. mm. Cu. No biological differences attributable to the source of radiation *per se* were noted. For each case the tumor dose was determined by conventional methods (9). The integral dose was estimated from Table I. The table specifies the h.v.l., T.S.D., field size, and thickness (total depth) of the patient; the integral dose is expressed in gram-roentgens per roentgen (skin dose).

From Mayneord's definition (19), it can be shown for a beam of x-rays emanating from a point source that the integral dose

$$\Sigma = \frac{A_o D_o}{X_o^2 \mu^2} [(X_o^2\mu^2 + 2X_o\mu + 2) - e^{-\mu d}(X^2\mu^2 + 2X\mu + 2)] \quad (1)$$

where

A_o = irradiated area (cm.²) of body surface
D_o = dose (r) to A_o
X_o = distance (cm.) from x-ray target to skin
d = depth (cm.) below skin surface
$X = X_o + d$
μ = absorption coefficient

The value of μ was computed for the various conditions of treatment pertinent to this study, with the depth-dose tables for water phantoms given in Supplement No. 5 of the *British Journal of Radiology*. It was found to vary slowly with depth. To

TABLE II. EFFECT OF ROENTGEN IRRADIATION ON THE NEUTROPHILS AND LYMPHOCYTES

Group	Case No.	Tumor Dose (in r) and Treatment Time (in days)	Integral Dose Rate (megagram-r per day)	Neutrophil Count: Initial cells/c. mm.	Neutrophil Count: Middle* % (days)	Neutrophil Count: Final* % (days)	Lymphocyte Count: Initial cells/c. mm.	Lymphocyte Count: 25% Level:* Integral Dose (megagram-r) and Time (days)	Lymphocyte Count: Final* % (days)
1*a*. Pelvis	1–10	3,500 36 ± 1.7	0.87 ± 0.18 0.014 ± 0.003†	6,100 ± 3,200	75 (19)	74 (34)	2,900 ± 1,500§	15.7 (18) 0.25‡	16 (34)
1*b*. Pelvis—extra cases	15, 17, 20, 22, 26, 27	3,600 34 ± 4.8	0.98 ± 0.19 0.015 ± 0.003†	4,400 ± 1,400	.....	84 (35)	2,700 ± 700	<34 (<35)	14 (35)
2. Pelvis (Price)	15‖	3,200 32	1.86	.....	.....	.....	2,000 ± 700	16.8 (9)	8 (25)
3*a*. Pelvis + prior radium therapy	11–14	3,500 34	0.95 ± 0.18 0.014 ± 0.001†	5,000 ± 3,200	80 (19)	84 (32)	1,100 ± 300	(See Case Notes)	[410 ± 90] cells/c. mm.
3*b*. Pelvis + prior surgery and transfusion	16, 19, 24	2,800 27	1.2 0.025†	4,700 ± 1,700	.....	104 (26)	3,000 ± 1,500	<31 (<26)	15 (26)
4. Abdomen	32, 34, 35	3,600 30–58	0.82 0.013†	4,400 ± 2,000	49 (21)	64 (28)	2,400 ± 600	15.5 (19) 0.25‡	15 (28)
5. Splenectomized		2,800							
Adult: Pelvis	37	31	0.94 0.016†	10,900	68 (16)	38 (31)	3,400	21 (23) 0.37‡	16 (31)
Child: Abdomen#	36	3,500 35	0.23 0.012†	7,400	30 (18)	22 (34)	3,900	3.5 (15)# 0.18‡	8 (34)
6. Chest	63, 66, 67, 80, 91	1,000–6,500 13–55	0.48 ± 0.11 0.008 ± 0.003†	8,400 ± 3,900	59 (9–20)	78 (27–53)	3,000 ± 800	12 (25)#	16 (35)
7. Larynx	47, 49, 50	6,300 37	0.042 0.0005†	4,300 ± 2,000	85 (17)	92 (36)	2,800 ± 400	>1.5 (36)	72 (36)
8. Antrum—nose	38–41	4,900 39	0.16 ± 0.04 0.003 ± 0.0006†	5,500 ± 1,800	108 (15)	113 (34)	3,200 ± 800	>5.4 (34)	53 (34)
9. Nasopharynx	43	6,000 49	0.08	4,100	120 (15)	65 (48)	2,000	>3.8 (48)	40 (48)
	42, 44	4,000–6,000 41	0.27	5,300	100 (16)	110 (43)	1,900	9.7 (36)	23 (43)
10. Neck	90	4,300 35	0.09	3,300	85 (15)	82 (30)	3,300	2.3 (26)	12 (30)
11. Pharynx (Bush)	26‖	6,000 (?) 42	0.13	.....	.....	.....	2,500 ± 600	4.3 (33)	21 (42)
12. Brain	56	1,500 34	0.025	3,700	.....	87 (34)	1,500	>0.84 (34)	133 (34)
	55	5,000 50	0.046	6,100	78 (21)	62 (56)	3,700	>2.6 (56)	60 (56)
	60	4,500 45	0.091	5,500	67 (17)	93 (42)	2,700	>3.8 (42)	45 (42)
13. Thigh	92	6,000 49	0.32	4,600	72 (20)	82 (42)	2,900	>13.4 (42)	120 (42)

* Relative count, taking the initial count as 100%. † Specific integral dose rate, megagram-r/kg.-day. ‡ Specific integral dose, megagram-r/kg.
§ If Case 9 is omitted, the initial count is 2,500 ± 600, and the final count is 19 per cent of the original. The mean ± the standard deviation estimate the range in which two-thirds of the counts fall. ‖ Not a case number, but the total number of cases averaged. # See Case Notes.

correct for this, the integral dose, Σ, was calculated from

$$\Sigma = D_e A_e(\Sigma_a + K_b\Sigma_b + K_c\Sigma_c) \qquad (2)$$

where the subscripts a, b, and c refer to successive volume increments along the path of the beam in which μ is considered constant and to which Equation 1 was applied. The values of μ for the various conditions of treatment were drawn up. The value of Σ_{a-c} was then computed from Equation 1 for depths between 0 and 50 cm., for each of the required values of X_e (50 and 70 cm.), and of μ (0.08–0.20). The values of Σ (Table I) were calculated from these data and Equation 2.

Leukocyte Counting: The initial counts of 3 patients in group 1*b* (Table II) were done in the hospital clinical laboratory. The other counts in Table II were done as follows. For each patient, all were done by *one* research technician, almost always at the same time of day, with chambers and pipets conforming to Bureau of Standards requirements. For the differential count, 200 cells were counted, usually from two smears. The total leukocyte figure was determined from a count of 16 squares, on 2 chambers, loaded by 2 pipets. Eosinophils were counted according to Randolph (26). In 29 cases where the greatest accuracy was desired, the counting procedure was repeated on two successive or closely spaced days, and the data of both determinations were averaged. Frequently, toward the end of a long course of therapy, the number of disintegrating cells in the smear increased appreciably, and the distinction between lymphocytes and monocytes became less clear. The counts are expressed in *cells per cubic millimeter ± the standard deviation of the observations*, thus defining the range in which two-thirds of the counts fell. They are referred to the days elapsed since treatment was begun on day zero.

Analysis of Data: The variations in neutrophil and lymphocyte counts which are found when a normal population is sampled reflect constitutional differences as well as normal variation and technical error. Chamberlain, Turner, and Williams (4) found that healthy individuals may have consistently high or low counts. Such constitutional differences influence

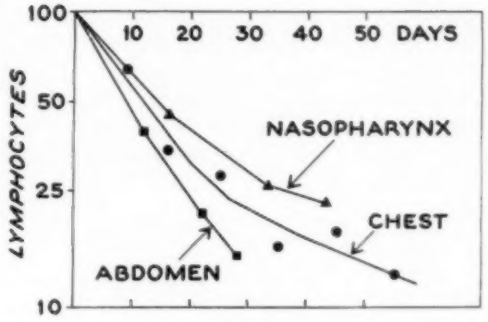

Fig. 2. Relative lymphocyte count (initial count = 100 per cent) during treatment.

the magnitude of the changes that occur following radiation therapy. Minot and Spurling (22) compared a group of 8 patients whose initial neutrophil and lymphocyte counts were 5,800 and 2,300, respectively, with a group of 14 patients whose initial counts were 4,300 and 1,200. The counts for the two groups remained distinctly apart during the month they were followed. A re-analysis has been made of Price's (25) data for 15 cases of lower abdominal or pelvic carcinoma (omitting the case of lymphosarcoma) treated with x-rays for four weeks. The initial lymphocyte count of the "lower" 8 cases was 1,500 ± 77; of the "upper" 7 cases it was 2,600 ± 250. The first-, second-, third-, and fourth-week counts, as a percentage of the initial count, were: "lower" group, 53, 20, 12, and 8; "upper" group, 51, 19, 12, and 8.

In the present work the data for each cell type were studied separately, expressed in both absolute (cells/c.mm.) and relative (per cent) units. To calculate the relative count, the initial absolute count of the cell was taken as the standard and the subsequent counts were expressed as percentages of it.

Curves such as those in Figures 1 and 2, for individuals or groups, showed that the rate and magnitude of the fall in lymphocyte count depended upon the rate and amount of treatment. To facilitate comparisons, two parameters were determined when the relative count reached the 25 per cent level: (*a*) the time elapsed since the

which two-thirds of the counts fall. ‖ Not a case number, but the total number of cases averaged. # See Case Notes.

beginning of treatment and (*b*) the integral dose received during that period. These data are presented in Table II. The 25 per cent level was chosen because it was far below the pre-treatment level, and yet was high enough that it could be determined conveniently.

CLINICAL MATERIAL AND DATA

The initial selection of patients was made with the following criteria in mind: (*a*) no previous radiation therapy; (*b*) no primary disease of the blood or of the reticuloendothelial system; (*c*) no transfusions within the preceding month; (*d*) no major operation within the preceding month; (*e*) good general health; (*f*) radiation therapy to be of a relatively well standardized type, given five or six times per week during four to six weeks. Usually all of these criteria were satisfied. Some exceptions are specifically noted. In particular, groups 3*a* and 3*b* were included to determine the effects of recent radium therapy or laparotomy and transfusion. It is believed that in the majority of cases the systemic effects of disease were small and that the changes in leukocyte count reported would occur in normal persons similarly irradiated.

Ninety-two cases were examined, of which 48 are reported (Table II). The discarded cases, although instructive, were unsuitable because of type or stage of disease, inadequate counts, or unsuitability for integral dose calculations. Of the 48 cases, 43 were of malignant and 2 of benign neoplasms, proved by biopsy. Three diagnoses were made without biopsy (degenerative disease of the cervical cord, acromegaly, and cyst of the cervical cord seen at operation but not incised).

For presentation in Table II, the cases were divided into 13 major groups, chiefly on the basis of the region of the body irradiated. Within a group, counts for cases treated at approximately the same integral dose per day were averaged. Special details concerning the groups, including their average initial monocyte, eosinophil, and basophil counts are as follows:

Case Notes

Group 1a. Carcinomas: cervix, 1 (I), 6 (II), 1 (III); corpus uteri, 1; mesenchymal tumor of uterus, 1. The high standard deviation of the initial lymphocyte count was due to Case 9. This patient's initial leukocyte count was 18,000, including 6,800 lymphocytes. Excluding Case 9, the initial lymphocyte count was 2,500 ± 600, monocytes 280 ± 170, eosinophils 210 ± 240, basophils 49 ± 62.

Group 1b. Carcinomas: cervix, 3 (II), 1 (III), 1 (IV); endometrium, 1. Initial counts of 3 cases were done in the hospital clinical laboratory. Not enough intermediate counts were done to calculate the time at which the 25 per cent relative lymphocyte count was attained. Monocytes 210 ± 210, eosinophils 180 ± 200, basophils 60 ± 50.

Group 2 (cases reported by Price). Carcinomas: ovary, 13; cervix, 1; liver, 1. Only lymphocyte counts were reported. h.v.l. of x-ray beam, 1.55 mm. Cu.

Group 3a. Carcinoma of cervix, 2 (I), 1 (II), 1 (III). Each patient had received two thirty-hour radium applications at about twelve and five days prior to x-ray therapy. The total milligram-hours were 4,900 to 5,300, 60 per cent from two vaginal ovoids and 40 per cent from an intra-uterine tandem. The radium integral dose was estimated to be 7.5 megagram-r, based on Mayneord's (21) method. X-ray therapy was like that given Groups 1a and 1b. Special counts prior to radium therapy were not done. The average of the pre-radium lymphocyte counts in the hospital clinic was 1,625 ± 360, an exceptionally low figure when compared to the averages shown in Tables II and III. The initial lymphocyte count at the beginning of x-ray therapy was 1,100 (Table II), which showed that radium therapy had depressed the count. The final count of 410 ± 90 was about equal to that of other groups which had received the same total integral dose. It was 25 per cent of the preradium hospital count. If, however, the preradium count were assumed to be the usual 2,400, the final relative count would have been about 15 per cent, as in comparably treated groups, and the 25 per cent level would have been reached at an integral dose of 22 megagram-r. Monocytes 260 ± 50, eosinophils 220 ± 80, basophils 70 ± 40.

Group 3b. Carcinomas: ovary, 2; uterus, 1. Each patient had been subjected to hysterectomy and bilateral salpingo-oöphorectomy seven to fourteen days prior to x-ray therapy. All had received transfusions. The average relative lymphocyte count for the 3 cases was 15 per cent on day twenty-six, but one of the cases had a count of 28 per cent and therefore did not reach the 25 per cent level. Monocytes 390 ± 80, eosinophils 330 ± 190, basophils 62 ± 55. The data indicate (Table II) that recent laparotomy and transfusion did not cause a major change in the reaction to x-rays.

Group 4. Carcinoma of ovary, 1; carcinoma of testis, 1; seminoma of testis, 1. Monocytes 170 ± 110, eosinophils 190 ± 120, basophils 60 ± 66.

Group 5. Carcinoma of ovary, 1; neuroblastoma, 1. Case 37 was that of a thirty-one-year-old woman who three years previously had undergone splenectomy for thrombocytopenic purpura. X-ray therapy to the pelvis and lower abdomen was begun fourteen days after hysterectomy and salpingo-oöphorectomy. The changes in the counts indicated that splenectomy had not affected their reaction to radiation. The neuroblastoma patient was a six-year-old girl whose spleen had been removed during partial excision of the tumor. X-ray therapy was begun twelve days later, when the leukocyte count had risen from a preoperative level of 5,400 to 11,600. The initial counts in Table II are based on the latter figure. If the preoperative count had been used as a base line, the relative lymphocyte count would have reached the 25 per cent level on day twenty-three of x-ray therapy at a specific integral dose of 0.28 megagram-r/kg.

Group 6. Degenerative disease of spinal cord, 1; carcinomas: bronchus, 2; esophagus, 1; breast (invasion of chest wall), 1. Because of variety in type, severity of disease, and frequency of complications, it was difficult to obtain a chest series. The 5 selected cases had an integral dose rate of 0.48 ± 0.1 megagram-r/day, and the relative lymphocyte counts were pooled while the patients remained under treatment. A smooth curve was drawn through the 21 counts referred to 6 treatment intervals, and from it was obtained the twelve-day estimate for the time required to reach the 25 per cent lymphocyte level recorded in Table II. Two of the cases, however, did not actually reach the 25 per cent level. Case 57 was followed during only nine days of treatment, presumably too short a period. For Case 80, in which there was a very large infected ulcer in the chest wall, the level fell only to 31 per cent in twenty-seven days. The change in the neutrophil count at the middle of treatment listed in Table II is based on the average counts from 4 cases, and in the final period, upon 3 cases. Monocytes 570 ± 240, eosinophils 200 ± 150, basophils 72 ± 60.

Group 7. Carcinoma of larynx, 3. Monocytes 160 ± 40, eosinophils 130 ± 70, basophils 77 ± 23.

Group 8. Carcinomas: nasal septum, 1; antrum, 2; plasmacytoma of maxilla, 1. Monocytes 370 ± 80, eosinophils 450 ± 490, basophils 38 ± 44.

Group 9. Carcinoma of nasopharynx, 3. Monocytes 300 ± 150, eosinophils 130 ± 70, basophils 49 ± 35.

Group 10. Cyst of cervical cord, 1. Monocytes 460, eosinophils 290, basophils 72.

Group 11. Averaged data for 26 cases reported by Bush (3). There were 7 lesions in the pharynx, 1 in the post-cricoid area, 1 in the larynx, 2 in the floor of the mouth, and 2 in the tongue. For 13 other similar cases used in the report the site of the lesion was not given. Only lymphocyte counts were reported. The source of radiation was a 5-gram teleradium unit. The relative biological effectiveness of such a beam compared to x-rays of 1 to 2 mm. Cu h.v.l. might be less than one.

Group 12. Acromegaly, 1; cerebellar astrocytoma, 1; hemangioendothelioma of the middle fossa, 1. Monocytes 220 ± 70, eosinophils 140 ± 80, basophils 0.

Group 13. Periosteal fibrosarcoma of thigh, 1. Monocytes 130, eosinophils 1,000, basophils 130.

Basophils: No consistent change was found in the basophil count. The average for all cases was 50 initially and 40 at the end of treatment.

Eosinophils: No consistent change correlated with amount of treatment was noted in the eosinophil count. In some cases a significant change in the count did occur, but this seemed to be due to allergy or other factors peculiar to the patient. Porter (24) noted an abrupt, transient 50 per cent fall in eosinophil count some hours after the acute onset of nausea, with or without vomiting. Such attacks were infrequent in the present series. In the one case examined under the conditions noted by Porter, the morning and afternoon counts during the bout were 205 and 170 respectively, compared to 66 and 110 during the preceding two weeks and 167 during the following week.

Monocytes: For all cases the initial monocyte count was 320 ± 195; the final count, 347 ± 183. In group 1*a*, the 5 cases with initial counts averaging 149 ±103 rose during treatment to a final count of 337 ± 54, whereas the 5 cases with an initial count of 418 ± 109 had a final count of 432 ± 118. The tendency of the count to rise from a low level was not found in other groups.

Neutrophils: The neutrophil count, though variable, tended to fall during the first half of the treatment period in the more heavily irradiated patients. The "larger dose" groups, 1, 3*a*, 4, 5 (adult), and 6, received 0.48 to 1.7 megagram-r/day to the trunk. The "smaller dose" groups, 7, 8, 9, 10, and 12, received from 0.03 to 0.3 megagram-r/day to the neck or head. The average of the counts for the cases in

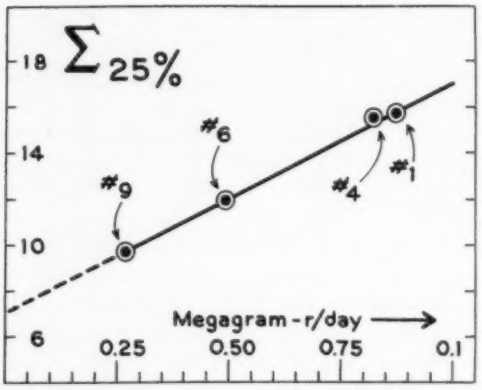

Fig. 3. Σ, *the integral dose at which the lymphocyte count reached 25 per cent of its initial level,* is plotted against the *daily integral dose.* Numbers attached to points refer to groups in Table II.

the larger and smaller dose groups at the beginning, middle, and end of treatment were, respectively:

Larger dose: 6600, 4500 (69%), 4800 (73%)
Smaller dose: 4900, 4600 (95%), 4700 (96%)

The cases that received the greater dose also had a higher initial count, presumably due to inflammation. The fall in count might therefore have been due to the control of inflammation as well as to the direct effect of the x-rays upon the myeloid system.

Lymphocytes: Both the absolute and relative decline in the lymphocyte count were correlated with the integral dose, but not with the tumor dose (Table III). The data indicate that, by and large, the minimum integral dose required to depress the count to the 25 per cent level lies between 7 and 10 megagram-r, corresponding to a specific integral dose of 0.1 to 0.15 megagram-r/kg.

The data of Table II, based on group averages and tabulated below, show that the larger the daily integral dose, the shorter the time required to reach the 25 per cent level.

Group 9, 0.28 megagram-r/day, 36 days
Group 6, 0.48 megagram-r/day, 25 days
Group 4, 0.82 megagram-r/day, 19 days
Group 1*a*, 0.87 megagram-r/day, 18 days

The changes in lymphocyte count as a function of time are illustrated in Figures 1 and 2.

DISCUSSION

Present findings with respect to changes in the various leukocyte counts confirm and extend previous findings (1, 7, 10, 11, 14, 15, 16, 22, 23, 27). As noted by Kornblum *et al.* (15), tumor dose *per se* (roentgens) does not determine the magnitude of the changes in lymphocyte count when all cases are considered. That the integral dose (megagram-r) is a major factor, as predicted by Mayneord (19), is indicated by two lines of evidence. First, the magnitude of the fall in the absolute and relative lymphocyte counts was correlated with the size of the integral dose (Table III). Secondly, as illustrated in Figures 1 and 2, the rate of fall in the lymphocyte count was correlated with the integral dose rate (megagram-r/day). The failure of Ellis (8) to find such effects was perhaps due to the small number of "unselected" patients examined under trying war-time conditions.

The data indicated that 7 megagram-r was the approximate minimum dose to

TABLE III: LYMPHOCYTE COUNT

Datum	Low Integral Dose Group	High Integral Dose Group
Tumor dose (r)	4,500 ± 1,900§	3,800 ± 1,000
Integral dose megagram-r	0.8–7.0	7.9–59
megagram-r/day	0.025–0.30	0.23–1.7
No. of cases	14	34
Initial count (cells/c. mm.)	2,900 ± 770	2,700 ± 1,090
Median	2,900	2,400
Range	1,500–4,200	1,300–6,800
Final count	1,500 ± 660	470 ± 180*
Relative final count†	*Cases*	*Cases*
5–25%	2	26
26–31%	0	7
Above 37%	12	1‡

* Excluding Case 92.
† Relative to the patient's own initial lymphocyte count.
‡ Case 92, in which the relative final count was 120 per cent.
§ The mean ± the standard deviation estimate the range in which two-thirds of the counts fall.

reduce the relative lymphocyte count to 25 per cent (Table III; Fig. 3). Several major exceptions to this statement require mention. In the low-dose group of Table III, Case 90 (Group 10) had a relative count of 12 per cent at a final dose of 3 megagram-r, for no apparent reason. The other low-dose exception was on the borderline (Case 91 of Group 6, 25 per cent at 6 megagram-r). In the high-dose group, the major exception was Case 92 (Group 13), with a relative count of 120 per cent at a final dose of 15 megagram-r. Case 92 had been treated to the thigh and knee, whereas all other cases had been treated to the head, neck, or trunk. It is suggested that a difference in regional sensitivity was the decisive factor. More cases bearing on this point are needed. Seven borderline exceptions were noted, including 2 in which initial counts were based on single determinations in the clinical laboratory.

For the pharyngeal series reported by Bush (Group 11, Table II), the "25 per cent lymphocyte dose" is estimated at about 4 megagram-r. This is considerably below the present findings and might be the result of technical differences in dose calculation or treatment. On the other hand, the estimate for the pelvic series reported by Price (Group 2, Table II) is about 17 megagram-r, in agreement with the present findings (Group 1*a*).

For the groups of the present series, the integral dose at the time the relative lymphocyte count reached 25 per cent ($\Sigma_{25\%}$) varied from 10 to 20 megagram-r. To determine whether or not this variation might be attributed to differences in the integral dose rate (R in megagram-r/day), the value of $\Sigma_{25\%}$ was plotted as a function of R (Fig. 3). The equation of the line fitting the points is

$$\Sigma_{25\%} = 10\,R + 7$$

suggesting that dose-rate was a major factor.

The fit of the points by a straight line in Figure 3 is better than might be expected when the possible sources of error are considered. Granting that the form of Equation 3 and the values of its constants may not be precisely determined, two of its major implications are worth considering. First, the equation predicts the minimum value of $\Sigma_{25\%}$ to be 7 megagram-r, an estimate that is consistent with the data of Table III. Second, the equation states that the smaller the daily integral dose, the smaller will be $\Sigma_{25\%}$. This prediction is confirmed when the data of Bush and Price are compared. It would be of great interest to know experimentally if the injurious effect per megagram-r continues to increase as the daily dose falls to zero. If so, it might help to explain the increased incidence of leukemia in radiologists (18). The estimation of the maximum permissible dose (28) would also be affected. Applied to radiation therapy, the findings suggest that, for a given integral dose, treatment be given quickly to spare the lymphatic system; slowly to depress it. In this respect the lymphatic system apparently differs from the skin, which has greater tolerance at low dose rates.

A new term, *specific integral dose*, was defined as the integral dose per kilogram of body weight. Integral dose is a physical term, having the dimensions of energy. Specific integral dose, having the dimensions of energy per mass of organism, is a biophysical term associated with the concept of organism. The recent findings of Court Brown and Mahler (2) may be expressed in terms of the specific integral dose. Following single doses of x-rays (2.5 to 5 megagram-r), they found the speed with which radiation sickness occurred to depend more closely upon the specific integral dose than upon the integral dose. In the present study, the specific integral dose was useful in one case, where it brought the data for a child into line with that for adults (Case 36, Group 5). While its use in other cases did not influence the conclusions reached, it seems likely that it will be valuable in those studies aiming at the greatest degree of refinement.

It is remarkable that partial-body irradiation can depress the function of a system as widely dispersed and as fully provided with reserves as the lymphatic, and it is even more remarkable that for the regions tested thus far, excepting the leg, the response seems to depend more upon the integral dose and dose rate than upon the amount and kind of tissue irradiated. In part, this might be accounted for by direct injury of the blood cells which pass through the irradiated field each day during treatment. But other factors may be important. Trowell's results (29) indicated that lymphocytes within the nodes are five times as sensitive to x-rays as those in the circulation, and the fixed or relatively fixed tissues within the field receive a much greater dose than the circulating cells. In this connection, a comparison of the responses to irradiation of the brain (high blood flow, no lymphatics), the abdomen (high flow, many lymphatics), and the leg at rest (low flow, few lymphatics) would be of interest.

Perhaps the importance of the integral dose indicates the existence of an ubiquitous mechanism that plays a decisive role in regulating the lymphocyte count. Such a mechanism would provide a basis for the indirect effect of radiation, a possibility discussed since the earliest investigations (13, 17). It is of interest that Denstad (6), who studied the marrow of the sternum or iliac crest before and after x-ray therapy to other parts of the body, concluded that changes occurred which should be attributed to the indirect effects of the radiation. With respect to acute radiation sickness, Court Brown and Mahler have presented evidence indicating the importance of a humoral factor.

SUMMARY

The change in count of each kind of leukocyte was followed in 48 selected patients undergoing a conventional course of x-ray therapy, planned for four to seven weeks. The tumor dose varied from about 3,000 to 6,000 r; the integral dose varied from about 1 to 50 megagram-r. A table for the estimation of the integral dose is presented. A new unit, the specific integral dose (megagram-r/kg.), is introduced.

No significant change related to radiation dose was found for the basophil, eosinophil, or monocyte counts, or for the neutrophil count in patients receiving less than 10 megagram-r. In patients receiving more than 10 megagram-r, the neutrophil count, though variable, on the average fell to about 70 per cent of its initial level by the middle of the treatment period, thereafter remaining at about that level.

The lymphocyte count tended to fall gradually throughout the course of treatment. Although several exceptions were noted, for irradiation of the trunk, neck, and pharynx, the magnitude and rate of fall of the lymphocyte count depended primarily upon the integral dose and integral dose rate rather than upon the tumor dose or the kind of tissue irradiated. At integral dose rates of 0.25 to 1 megagram-r/day, the smaller the daily dose, the smaller the total integral dose required to reduce the lymphocyte count to 25 per cent of its initial level. The minimum dose for this effect was about 7 megagram-r.

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Radiological Laboratory
University of California Medical Center
San Francisco 22, Calif.

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SUMARIO

Alteraciones de la Fórmula Leucocítica Humana Durante la Roentgenoterapia por Cáncer y su Subordinación a la Dosis Integra

En 48 enfermos escogidos mientras tomaban una serie convencional de roentgenoterapia, calculada para 4 a 7 semanas, se observaron los cambios en las numeraciones de cada clase de leucocitos. La dosis tumor varió de unos 3,000 a 6,000 r. La dosis íntegra varió de aproximadamente 1 a 50 megagramos-r. Preséntase una tabla para computar la dosis íntegra. Introdúcese una nueva unidad, la dosis íntegra específica (megagramo-r/kg.).

No se observó mayor alteración relacionada con la dosis de radiación en las numeraciones de basófilos, eosinófilos o monocitos, ni en la numeración de neutrófilos en los enfermos que recibieron menos de 10 megagramos-r. En los que recibieron más de 10 megagramos-4, la fórmula neutrófila, aunque variable, descendió, por término medio, a 70 por ciento aproximadamente de su tenor inicial hacia mediados del período de tratamiento, manteniéndose después más o menos a dicha cifra.

La fórmula linfocítica tendió a bajar paulatinamente durante toda la serie de tratamiento. Aunque se notaron varias excepciones, la magnitud y la velocidad de la baja de la fórmula leucocítica se subordinaron primordialmente a la dosis íntegra y a la frecuencia de la dosis íntegra más bien que a la dosis tumor o a la clase de tejido irradiado. A frecuencias de dosis íntegra de 0.25 a 1 megagramo-r/día, mientras menor era la dosis diaria, menor era la dosis íntegra requerida para rebajar la fórmula leucocítica a 25 por ciento de su cifra inicial. La dosis mínima para obtener este efecto fué de unos 7 megagramos-r.

Further Comparative Studies of X-Ray Transmission Through the Abdomen in Living Subjects[1]

JOSEPH R. NAHON, M.D.[2]

IN AN EARLIER paper on x-ray transmission through the human body (1) a graph was included in which the exit doses in roentgens for the thorax and abdomen, as determined in 100 subjects, were plotted and compared. A review of this scattergram, reproduced here as Figure 1, shows that the mean or average of the abdominal readings describe an approximate exponential curve, whereas the readings in the chest yield groupings which show no such particular order.

The probable explanation of these observations lies in the relative homogeneity of the abdomen and chest structures. Depth dose determinations in a homogeneous substance take the form of a more or less smooth exponential curve. Certainly in their course through the abdomen, x-rays do not traverse a homogeneous substance. Skin, muscle, fat, intestinal contents, and gas must all have differing densities. Nevertheless, in the main, since the abdomen comprises various materials with a high water content, it may be said to be relatively homogeneous, certainly, far more so than the thorax, where chest wall of about unit density, ribs and spine of 1.15 density (2), and pulmonary parenchyma of approximately 0.3 density must be traversed.

The marked difference in x-ray transmission through thorax and abdomen, as clearly shown by the diagram, deserves re-emphasis. This was the point of greatest practical significance in the previous article, and some approximate and advisable correction for this difference at various depths was indicated.

As one scrutinizes the abdominal readings, it is not unnatural to reflect that they were obtained through human bodies rather than artificial phantoms. The question then arises as to how such readings compare with those in phantoms of homogeneous material. If the resemblance is close, then the use of these artificial structures is legitimate; if they differ widely, then results obtained with phantoms should be accepted with reservation or, if possible, should be subject to correction. The possibility of an experimental check which would give useful information is thus suggested.

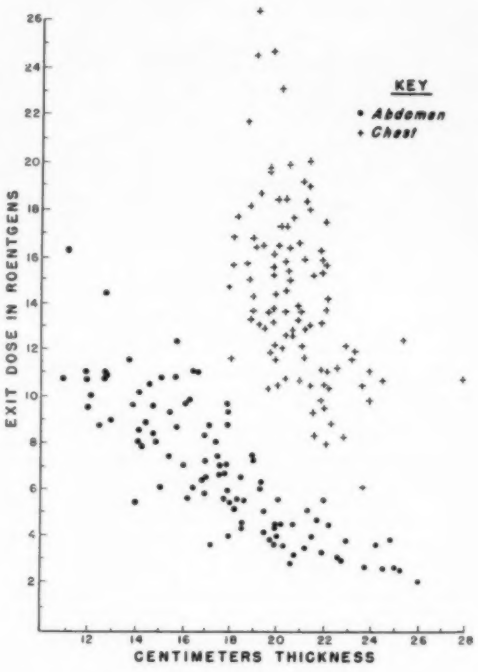

Fig. 1. Comparison of exit doses in roentgens per 81.2 r in air through thorax and abdomen of 100 living patients.

The readings recorded are not to be compared with depth dose data, since the table on which the patients lay did not supply back-scattered radiation equivalent to that from something like 10 cm. of unit density material. Nor do they represent

[1] From Veterans Administration Hospital, Brooklyn, N. Y. Accepted for publication in March 1954.
[2] At present, on the Radiological Service, Veterans Administration Hospital, East Orange, N. J.

Fig. 2. Masonite block with thimble chamber in place, half buried in the Masonite.
Fig. 3. Patient overlying Masonite block. The central axis of the beam passes through the abdomen, avoiding the spine, and through the tip of the thimble chamber.

true exit doses, since there was some back-scatter from the treatment table. Furthermore, depending on the degree of contact between the patient and the table, there may have been air spaces around the ionization chamber.

It seemed apparent that, if a patient could be placed in close contact with a block of unit density material, the backward scattered radiation reaching the chamber should be essentially the same as in a unit density phantom. Measurements taken between the patient and the block should then simulate depth-dose measurements for depths equal to the patient's thickness. If these values were found to be in agreement with depth-dose data taken with the same machine and ionization chamber, in a unit density phantom, the applicability of such depth-dose data to abdominal treatments would be confirmed; if they differed appreciably, an explanation should be sought.

The use of standard published depth-dose data for such a comparison, instead of data obtained for the individual set-up, would not be expected to introduce appreciable errors, although the comparison would be less exact. Small variations from published data are inevitable in particular cases, because of differences in phantoms, measuring instruments, diaphragm systems, etc.

PROCEDURE

A Masonite block was constructed having a moderately curved superior surface which fitted snugly into the lumbar region. A channel was cut in the upper surface of this block, to receive a thimble chamber in such fashion that the chamber would be half immersed in the material of the block (Fig. 2). Thus, when the patient lay with the lumbar region over the block, the skin fitted over the thimble chamber which, thus, was in complete contact with the patient above and with the Masonite beneath (Fig. 3). Readings were now made through an 8 × 10-cm. field so that the central axis of the beam passed through the center of the field on the anterior surface of the abdomen and through the tip of the thimble chamber on the under surface of the abdomen. The field was so placed as to avoid such bony structures as the wing of the ilium and vertebral column.

The factors were 250 kv, 15 ma, 50 cm. T.S.D., 1.5 mm. Cu h.v.l., 1 mm. Cu plus 1 mm. Al filtration. The calibration of the machine was 34.4 r per minute. Exposures of two minutes were used. A total of eighty readings were taken.

DISCUSSION

On comparing the new scattergram obtained under the foregoing conditions (Fig. 4) with the old (Fig. 5), perhaps the

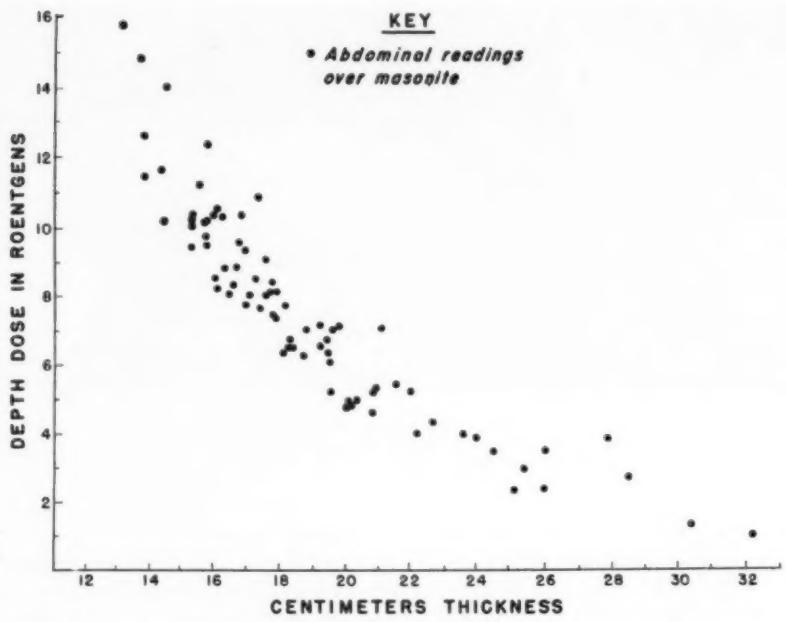

Fig. 4. Depth readings over Masonite, from 80 patients plotted against thickness of abdomen.

most obvious difference to be noted is the more limited "spread" of the individual readings. In other words, it is seen that for any given body thickness, when the body is backed with a Masonite block, the individual variations are decreased in degree. This is to be expected; it represents the "dampening" effect of the Masonite. It is to be remembered that the readings in Figure 4 are, in a sense, depth-dose readings. They are much influenced by the back-scatter from the Masonite block lying beneath the body. This back-scatter is a constant percentage of the radiation reaching it, not a constant amount. The original readings represented exit dose plus some uncertain back-scatter factor due to the table. The magnitude of this factor would vary, depending on patient thickness, say between 5 and 10 per cent. With the presdwood set-up, the readings also represent exit dose plus a back-scatter factor, the percentage of the latter being greater the greater the thickness of the body. The ratio of the old and new measurements should be

$$\frac{\text{exit dose plus per cent scatter from couch}}{\text{exit dose plus per cent scatter from presdwood}}$$

For the radiation in question, the *per cent* scatter from presdwood would be considerably greater at 24 cm. than at 14 cm.

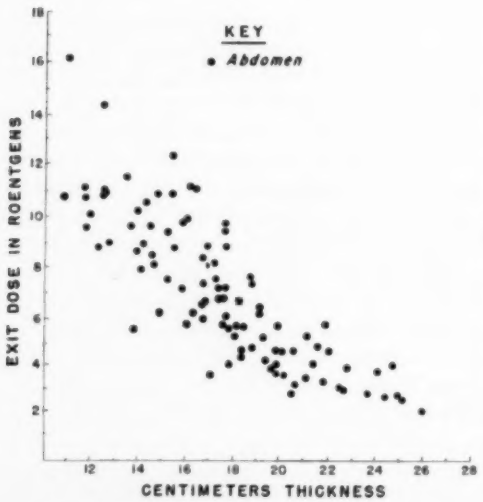

Fig. 5. Abdominal readings of Fig. 1 with the chest data removed for easy comparison with Fig. 4.

It is not possible to take a single per cent back-scatter for the field, because of the change in quality of the radiation; as it passes through more tissue it becomes softer and the scatter becomes greater.

It was next of interest to compare the new scattergram (Fig. 4), and the exponential curve which it suggests, with the fixed curve obtained by plotting the equivalent readings in a phantom. The readings in Masonite which make up the depth dose tables in the *Physical Foundations of Radiology* (3) were used. Such a comparison should really indicate how these partially true body depth readings compare with phantom readings. The readings on patients were taken with a beam having a half-value layer of 1.5 mm. Cu. This quality is not found in the tables referred to but can be obtained by interpolation. The results are shown in Figure 6, where the data are rearranged so that thickness of part is plotted against roentgens at depth per 100 r in air. It is seen that the disparity is not too great. The standard Masonite depth doses run consistently higher than the majority of the combined body and Masonite readings. If, however, one assumes a probable 10 per cent range of error for the abdominal readings and a 3 per cent error for the standard depth-dose readings, then the mean curve of the scattergram practically coincides with the curve from the standard depth doses.

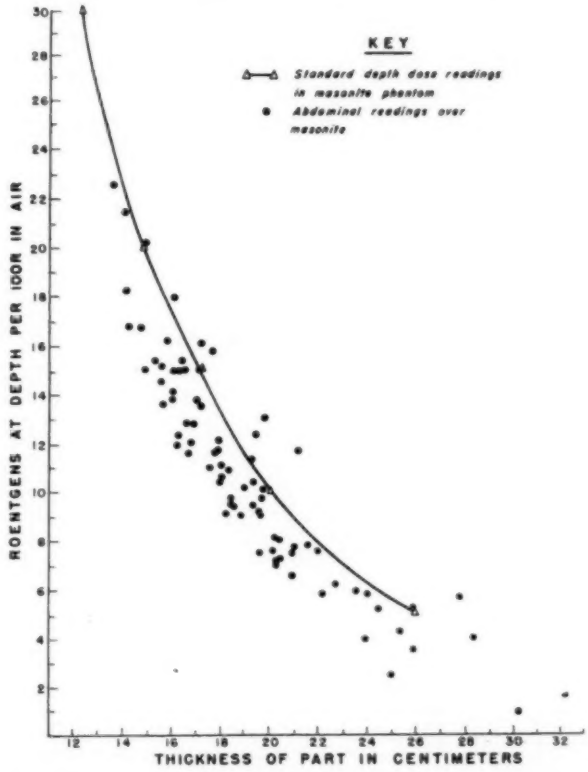
KEY
Standard depth dose readings in masonite phantom
Abdominal readings over masonite
ROENTGENS AT DEPTH PER 100R IN AIR
THICKNESS OF PART IN CENTIMETERS

Fig. 6. Comparison of abdominal readings over Masonite with standard depth dose readings in a Masonite phantom.

In Figure 7, three different sets of data are compared: the curve of the standard depth doses, the readings through the human abdomen backed by Masonite, and the exit doses through the human ab-

domen. The first two have already been discussed. The mean of the exit dose readings is seen to be definitely less than that of the combined readings of abdomen plus Masonite and, therefore, of course, considerably less than the standard Masonite readings. The difference cannot be explained by greater density; more probably, it is the result of lack of a dense medium distal to the thimble chamber to provide an adequate degree of back-scatter.

Although these findings are of a certain academic interest, their practical value may be somewhat limited. It is not to be inferred from this that treatment is to be administered from now on with the patient backed by Masonite. If the lesion to be treated were on the undermost side of the body, this would be desirable. But, in that case, it would be far simpler to turn the patient over and treat the lesion directly. On the other hand, where the tumor lies well inside the body, it is very doubtful that back-scatter from a Masonite block would reach the neighborhood of the growth and increase the depth dose. Only in the case of a thin part, such as a hand or foot or wrist or ankle, might an improvement in depth dose be anticipated by a Masonite backing.

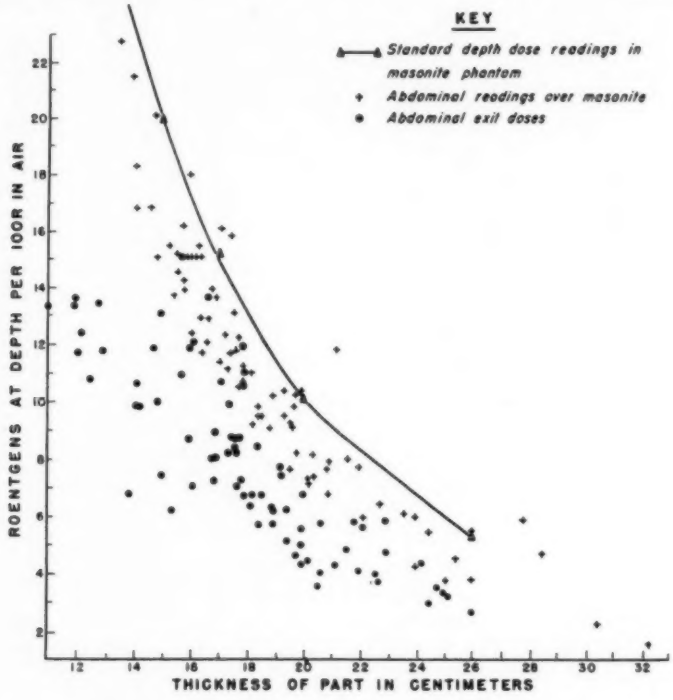

Fig. 7. Comparison of abdominal readings over Masonite, abdominal exit doses, and standard depth-dose readings in a Masonite phantom.

NOTE: Most grateful acknowledgment is made to Dr. Edith H. Quimby of the Radiological Research Laboratory, Columbia University, for her kindness in reviewing and correcting the original draft of this paper.

Veterans Administration Hospital
East Orange, N. J.

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SUMARIO

Nuevos Estudios Comparados de la Transmisión de Rayos X a Través del Abdomen en Sujetos Vivos

Comparáronse las lecturas de la dosis profunda obtenidas en el abdomen con el enfermo recostado sobre un bloque de Masonita de densidad igual a la unidad con datos para la dosis profunda *stándard* y con lecturas de la dosis de salida presentadas anteriormente (*v.* Radiology **58:** 241, 1952). Cuando se trazó la curva del espesor de la parte irradiada contra los roentgens obtenidos a profundidad por 100 r al aire, y se hicieron las concesiones necesarias para las escalas probables de error, resultaron ser prácticamente coincidentes la curva de la dosis profunda media obtenida con el enfermo recostado en el bloque de Masonita y la basada en los datos para dosis profunda *stándard*. Sin embargo, el promedio de las lecturas de la dosis de salida sin el bloque de Masonita fué decididamente más bajo, probablemente a consecuencia de la falta de un medio denso distal a la cámara de dedal en que se hicieron las mediciones, para suministrar una retrodispersión adecuada.

Estos hallazgos revisten importancia teórica más bien que clínica. Las lesiones superficiales se tratan más sencillamente con la irradiación directa, mientras que para los tumores situados dentro del cuerpo, es dudoso que la retrodispersión de la Masonita alcance la zona afectada y aumente la dosis.

Modification of Electron Filter to Improve Light Localization of a Cobalt-60 Beam[1]

JASPER E. RICHARDSON, Ph.D.,[2] and MARSHALL BRUCER, M.D.

THE DISTRIBUTION of ionization in the first few millimeters of tissue-like material was studied with a cobalt-60 teletherapy unit (1, 2). It was found that for short cone-to-skin distance (C.S.D.) the effect of electrons from the collimating system could be reduced appreciably by thin filters which did not noticeably affect the gamma-ray dosage pattern. Optimum results were obtained with the filter mounted over the lower end of the treatment cone. With this arrangement, however, the filter obscured the beam of light from the light localizer unless it was removed with each use.

The interference of a filter with light localization is not encountered with x-ray generators in which the filter employed to harden the beam is located above the mirror of the localizer. Below the collimating system of an x-ray generator, filters to reduce electron contamination are generally not needed, for several reasons. For units operating below the supervoltage region, the average energy of secondary electrons is low, and they are removed from the beam through air scatter even for short diaphragm-skin distances. Further, the focal spot of an x-ray generator is usually small in comparison with the size of a teletherapy source. Therefore, for a given focal skin distance, long diaphragm-skin distances can be used without resulting in wide penumbras. Filters to reduce electron contamination are not needed when the diaphragm-skin distance is large.

The low-activity sources employed in some teletherapy units necessitate treatment with short source-to-skin distances (S.S.D.) if the treatment time is to be kept within reasonable limits. If the penumbra width is to be kept small, this requires treatment at a short cone-to-skin distance, for which the electron contamination is appreciable.

To minimize the skin dose, it was felt advisable to use an electron filter for treatment close to the cone. It was also considered desirable to retain the light localizer without having to remove and replace the filter with each use. Since the purpose of a light localizer is to mark the outer extremities of the field, it was found possible to leave the filter attached to the cone without hindering this function of the localizer. In fact, the method developed is believed to have improved light localization.

METHOD OF MOUNTING FILTERS AND RESULTS

A Lucite cap, with bottom and walls of 1.5 mm. thickness, was constructed to fit over the end of the cone (Fig. 1). A sheet of cadmium, 0.25 mm. thick, was then attached to the Lucite so as to cover the opening of the cone except for a narrow slit (about 1 mm.) around the edges. With this arrangement, the filter can easily be removed if desired.

The light pattern from the localizer is shown in Figure 2. This pattern was made with the light from the bulb of the light localizer collimated so that its image in the mirror reproduced the source in both shape and position. It should be noted here that, if the inner lining of the cone is a reflecting surface, the light pattern will be a pair of bright bands parallel to each edge of the field and bisected by a dark line. The double band results from the two images of the light source: the image of

[1] From the Medical Division, Oak Ridge Institute of Nuclear Studies, Inc., Oak Ridge, Tenn., under contract with the United States Atomic Energy Commission. Accepted for publication in November 1953.

[2] Work done under Research Participation Contract. At present, Assistant Physicist, M. D. Anderson Hospital for Cancer Research, Houston, Texas.

the source in the mirror and a weaker image due to reflection of light from the brass lining of the treatment cone. These images are separated by twice the distance that the taper of the treatment cone misses the edge of the mirror image. The bright outer band represents light from the mirror image, while the dim inner band represents light from the cone image. The dark line results from the separation of the two images. If the taper of the treatment cone meets the edge of the mirror image, a dark line does not appear. Instead, one observes a transition from dim to bright light. The pattern shown in Figure 2 was obtained when the cone image was removed by coating the inside of the treatment cone with carbon. It was found that blackening the surface was not sufficient; the coating must be one that diffuses light.

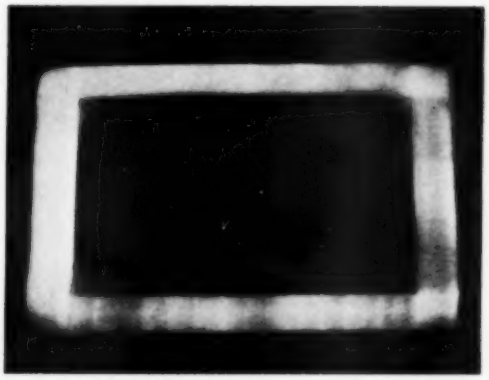

Fig. 2. Photograph of pattern from light localizer with Lucite-cadmium cap attached to end of treatment cone.

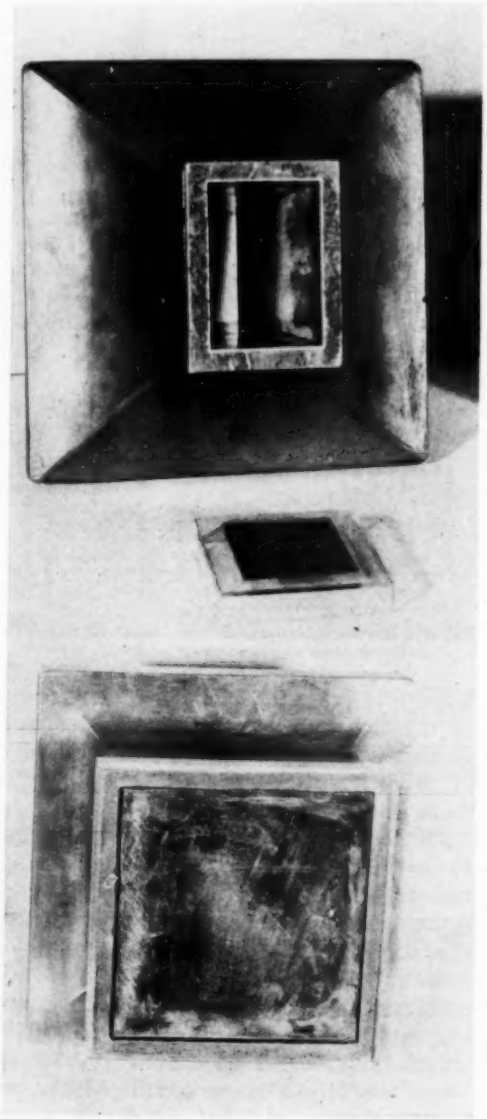

Fig. 1. Photograph showing construction of filter cap for a 4 × 6-cm. cone and attachment of filter cap to a 10 × 10-cm. cone.

EXPERIMENTAL RESULTS

The light pattern was studied experimentally by use of x-ray films. The films were placed at 125 cm. source-to-skin distance, 79 cm. cone-to-skin distance, which is much greater than the distances at which it is planned to use the unit. A large source-to-skin distance was chosen so that any error in alignment of the light beam with the gamma-ray beam which existed at shorter distances would be magnified and more easily detected. The films, wrapped in light-tight paper, were exposed to the cobalt beam with the light pattern outlined by short, narrow strips of lead. After development, the densities of the films were measured with a densitometer. Calibration films showed that the variation of film density

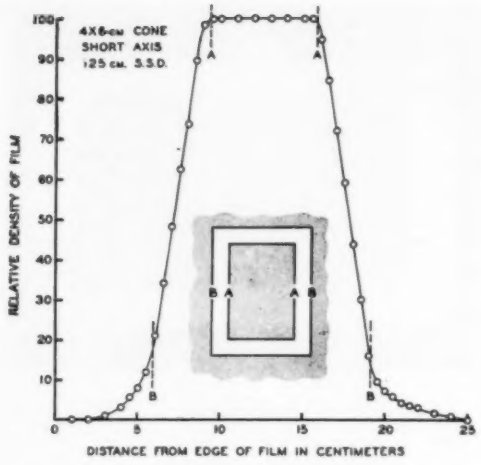

Fig. 3. Graph showing photographic measurements of cobalt-60 gamma-ray beam and borders between dark and light areas of light localizer pattern.

with intensity of radiation could be assumed to be linear within the accuracy of the measurements. The results shown in Figure 3 are measurements made across the short axis of the field from a 4 × 6-cm. cone. The dotted lines A-A and B-B are the edges of the lead strips marking the width of the dark area and total width, respectively, of the pattern shown in Figure 2.

The film measurements show that, to a close approximation, the dark area of Figure 2 represents the geometrical field of the cobalt beam. Calculations show that the bright band represents the geometrical penumbra. The true penumbra is greater than the geometrical penumbra because of (*a*) back-scattering from the medium below the film, (*b*) scattering of gamma rays from the sides of the cone, and (*c*) penetration of gamma rays through the lower edges of the cone. Since the dose received beyond the geometrical penumbra is wholly due to scattered radiation, it was felt that the greater sensitivity of the film to low-energy radiation might have resulted in its density in this region being a little high. A check with a Victoreen chamber indicated that the dose measured by the film density beyond the geometrical penumbra was too high by a factor of 1.6, which would lower the lines B-B to about 10 per cent. However, measurements made with a Victoreen chamber cannot be taken as accurate surface measurements. Furthermore, the value of the per cent dose at the edge of the geometrical penumbra will vary with source-to-skin dis-

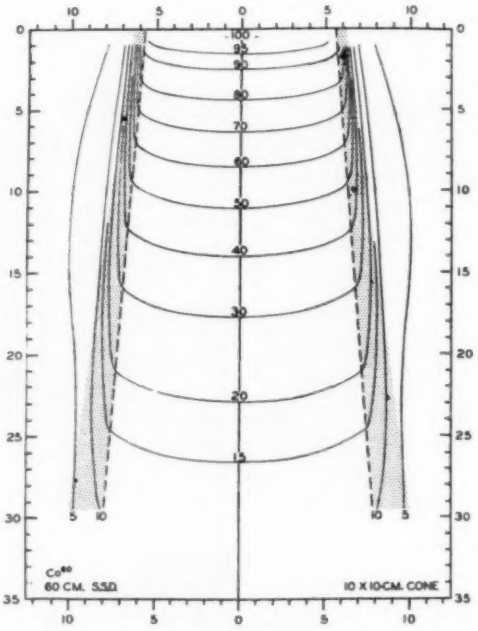

Fig. 4. Isodose distribution from cobalt-60 unit with geometrical penumbra shown as shaded area.

tance and field size. The close agreement of the light pattern with the calculated geometrical field and penumbra was found at all cone-to-skin distances for both a 4 × 6-cm. and a 10 × 10-cm. cone.

Not only do the results show it possible to use the light localizer without removing the filter, but the arrangement could prove useful when it is desired to distinguish between the field and the penumbra at the surface. Although the geometrical field could be calculated for the irradiation of a plane surface, the calculations would be somewhat difficult when the object being irradiated has an irregular surface. The band of light showing the geometrical penumbra is not meaningful by itself, but from it the therapist

should visualize the depth projection of the geometrical field as shown in Figure 4. For gamma rays of cobalt energies, the geometrical field closely represents areas where the dose rate is constant. The dose rate, however, does not fall to zero at the outer edge of the geometrical penumbra, and information concerning the true penumbra can be obtained only from isodose curves. The surface penumbra picture is useful, since it is found difficult to distinguish the field from the penumbra without the filter arrangement.

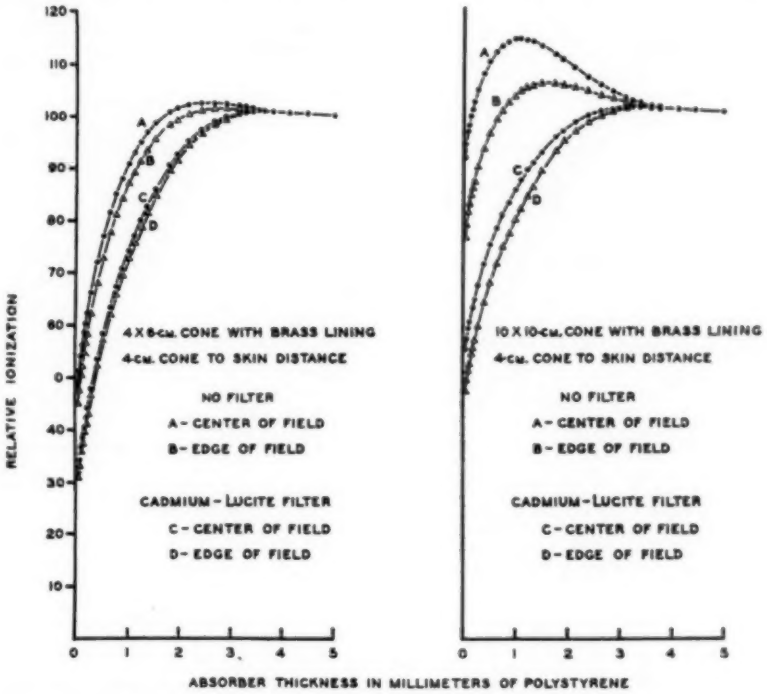
RELATIVE IONIZATION
4 X 6-Cm. CONE WITH BRASS LINING
4-Cm. CONE TO SKIN DISTANCE
NO FILTER
A - CENTER OF FIELD
B - EDGE OF FIELD
CADMIUM - LUCITE FILTER
C - CENTER OF FIELD
D - EDGE OF FIELD
10 X 10-Cm. CONE WITH BRASS LINING
4-Cm. CONE TO SKIN DISTANCE
NO FILTER
A - CENTER OF FIELD
B - EDGE OF FIELD
CADMIUM - LUCITE FILTER
C - CENTER OF FIELD
D - EDGE OF FIELD
ABSORBER THICKNESS IN MILLIMETERS OF POLYSTYRENE

Fig. 5. Graph showing the distribution of ionization in the first 5 mm. of tissue-like material with and without the filter cap.

The effect of the unfiltered strip of Lucite on the dose distribution at the edge of the field was measured. A shallow ionization chamber with an active volume 2 cm. in diameter and 1 mm. in depth was used to determine the relative ionization as varying thicknesses of tissue-like material were placed over the chamber. Although it was impossible, with a chamber of this diameter, to restrict the ionization measured to that at the edge of the field, it was felt that measurements would show whether or not the electrons from the Lucite produced an appreciable change in the skin dose. The ionization chamber was moved to the edge of the field, at 4 cm. cone-to-skin distance, until the outer edge of its active volume was at the midpoint of the penumbra. The results shown in Figure 5 indicate that the electrons from the unfiltered strip of Lucite do not constitute a serious problem. For both the 4 × 6-cm. and 10 × 10-cm. cones, the skin dose at the center of the field was greater than that at the edge. Measurements made at the center of the field with the cone opening entirely covered with a cadmium filter gave results identical with those obtained with the cap arrangement.

GEOMETRY OF VISIBLE LIGHT BEAM

The error in measuring the geometrical field and penumbra in this manner is

proportional to the width of the open slit (between the wall of the collimating cone and the electron filter) through which the light passes. The size of this narrow band is called the slit width. When the treatment cone has the "correct" taper, the light band is wider than the true geometrical penumbra by the amount ΔP (Fig. 6). The corresponding length of the dark area will be shorter than the true geometrical field by the amount 2ΔP. For a given cone-to-skin distance, this error will be independent of field size. When the taper of the treatment cone intersects the source, an additional factor must be taken into consideration, ΔP′ of Figure 6.

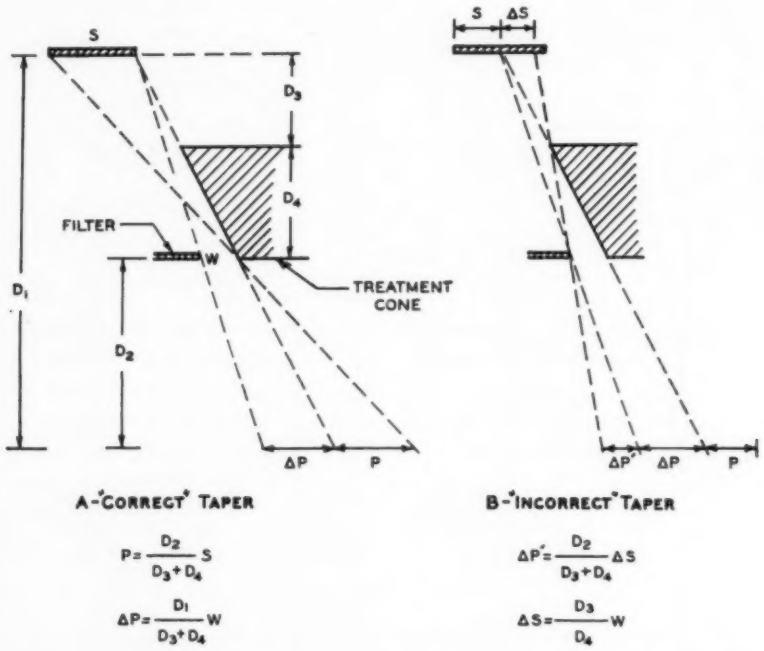

Fig. 6. Diagram showing geometry of visible light beam. The intersection of the cone taper with the source is exaggerated for the purpose of illustration.

Curve A of Figure 7 represents calculated values of P + ΔP with "correct" taper of the treatment cone and with the greatest source-skin distance possible (149 cm.). Measured widths of the light band are also shown. Curve B represents calculations for "incorrect" taper. Measurements for this condition were made by tilting the treatment cone in its holder. The extrapolation of the measurements to zero slit width was taken as the true value of P, from which the calculations were made. It was found that the cone taper intersected the source about 2 mm. from its nearest edge. The total width of the source was 20 mm. Curve B shows the possible error in calculating the geometrical field and penumbra when the taper of the cone is uncertain. For cones designed so that the taper intersects the source at its center, the geometrical penumbra could be measured by choosing that slit width corresponding to the sharp bend in the calculated curve.

The foregoing measurements were not made with the filter mounted on the Lucite cap because of difficulties in measuring the

slit width. With the sheet of Lucite between the filter and the cone, it was found that the diffusion of light in the Lucite had no observable effect on the boundaries between the dark and light areas and had only a slight effect on the contrast. It was also found that, with the light localizer of this unit, the slit width could be reduced to at least 0.5 mm. and still allow sufficient light to pass.

SUMMARY

When short cone-to-skin distances are used with cobalt-60 teletherapy units, it is advantageous to filter secondary electron emission with a thin sheet of cadmium over the cone aperture, in order to minimize the skin dose. If a narrow opening is left around the periphery of this filter, it can be further used to outline the geometrical penumbra. With this arrangement, a band of light delineates the true geometrical beam of gamma rays and the width of the geometrical penumbra.

ACKNOWLEDGMENT: The authors acknowledge the technical assistance of Harry E. Kimble.

Marshall Brucer, M.D.
Oak Ridge Institute of Nuclear Studies
Oak Ridge, Tenn.

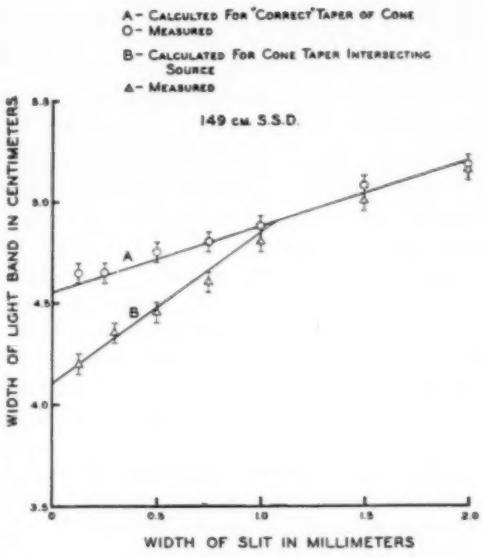

Fig. 7. Graph showing the calculated width of the light band and experimental measurements.

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SUMARIO

Modificación del Filtro de Electrones para Mejorar la Localización Luminosa de un Haz de Cobalto-60

Cuando se usan distancias cono-piel cortas con aparatos de cobalto-60 para teleterapia, resulta ventajoso filtrar la emisión secundaria de electrones con una hoja delgada de cadmio colocada sobre la abertura del cono. Si se deja una abertura estrecha alrededor de la periferia de ese filtro, puede además utilizarse para demarcar la penumbra geométrica. Con ese arreglo, una banda de luz delinea el verdadero haz geométrico de rayos gamma y el ancho de la penumbra geométrica.

A Device for the Measurement of Dose as a Function of Specific Ionization[1]

HARALD H. ROSSI, Ph.D., and WALTER ROSENZWEIG, M.S.

THE PHYSICAL parameters influencing the biological effect of ionizing radiation are the energy delivered to the tissues affected and the ion density along the paths of the charged particles producing the ions. Variations of the latter quantity are believed to be responsible for differences in relative biological effectiveness (R.B.E.). Zirkle has suggested the use of the concept of "linear energy transfer" (L.E.T.) in tissue. This is more fundamental than specific ionization in a gas, but the latter, which may be measured much more readily, may be presumed to be proportional to the former within about 10 per cent in most cases.

At present there are several methods by which the total energy imparted to tissue by ionizing radiations can be determined. In this laboratory, tissue-equivalent ionization chambers (1) have been developed on the basis of the Bragg-Gray principle. Employing these chambers, one can obtain a measure of the total energy delivered per gram of tissue by particles of any specific ionization. Since these chambers, when exposed to the same radiation field, are traversed by ionizing particles of the same type, energy, and direction as is tissue, it appeared feasible to develop a method whereby the specific ionization of individual particles crossing the cavity might be determined.

Since the ionization produced by individual particles will often be too small to be detected directly, recourse must be taken to gas multiplication. Hence the chamber must operate as a proportional counter. In this case the pulse obtained will be proportional to the ionization produced by the particle traversing the counter. The total ionization will be the product of specific ionization and path length in the gas volume. Discrimination on the basis of pulse height alone cannot lead to a clear distinction between particles of different specific ionization, since the pulse produced by a lightly ionizing particle having a long trajectory may be equally as large as that produced by a heavily ionizing particle having a short path. If the particles involved are of greatly different specific ionization, *e.g.*, electrons and protons, a reasonably satisfactory separation of pulses produced by either type can be achieved, and it is upon this basis that Hurst and Ritchie (2) developed their neutron dosimeter. If, however, detailed information on specific ionization is required, allowance must be made for the distribution of geometric path lengths. This may be done most easily for the simplest kind of cavity, which is a sphere. This shape has the additional advantage of being isotropic and directional response is thus absent.

Formula 1 in the Appendix gives a general expression for the distribution of path lengths intercepted by a spherical cavity at any distance from a point source. The most important practical case is the one where the source is effectively at infinity (*i.e.*, many sphere radii away). In this case the sphere is in a uniform radiation field and the distribution of path lengths is triangular (Equation 2 in Appendix). A uniform radiation field exists not only at a great distance from a point source but also in the interior of a distributed source, because in either case the number of particles traveling in any given direction is constant throughout the volume in question. For this reason, if a spherical cavity lined with tissue-equivalent material is irradiated by a parallel beam of neutrons, a triangular distribution of path

[1] From the Radiological Research Laboratory, Columbia University, New York, N. Y. This work was performed under Contract AT-30-1-GEN-70 with the U. S. Atomic Energy Commission. Presented at the Thirty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 13–18, 1953.

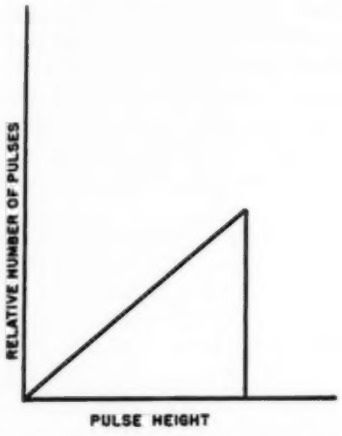

Fig. 1. Triangular pulse spectrum produced by particles of equal specific ionization.

lengths will exist not only for the neutrons but also for the secondaries produced in the wall of the cavity, provided there is no significant neutron absorption in the wall. The same will be true in the case of electrons produced by electromagnetic radiations provided the electrons cross the cavity in straight paths (*i.e.*, there is negligible scattering by the gas in the cavity).

The ionization produced by any particle will be the product of the path length and the specific ionization. Thus particles of any given specific ionization will produce a triangular ionization pulse spectrum (Fig. 1), and consequently the total pulse spectrum observed in general must be made up of a superposition of individual triangular sub-spectra (Fig. 2). If the initial ionization produced by each pulse is linearly increased both by gas and electronic amplification and the resultant pulses are separated according to height by a differential discriminating system, it should be possible to analyze the spectrum for individual triangular components. Since in practice there is a continuous distribution of specific ionizations, analytical methods are best employed. The results of the computation (Equation 9, Appendix) indicate that a determination of the dose, $D(\sigma)$, contributed by particles of specific ionization, σ, requires differentiation of the pulse spectrum obtained. On the other hand, if the dose between two values of specific ionization is required, such a differentiation is not necessary (Equation 10, Appendix). Since particles of any fixed specific ionization will contribute a triangular sub-spectrum, the shape of which is entirely determined by the leading edge, it is merely necessary to obtain a counting rate for particles in this group that travel through a major diameter of the counter. Thus, if it should be desirable to discriminate against pulses below a certain height because of noise, etc., the *total* dose due to particles that contribute any pulses larger than this limit can be computed. Similarly, if it is decided to use the device to measure doses contributed by particles above a certain specific ionization (excluding, for example, electrons over virtually their entire range), this may be done by merely obtaining the spectrum above a bias corresponding to the maximum pulse-height produced by the particles to be excluded.

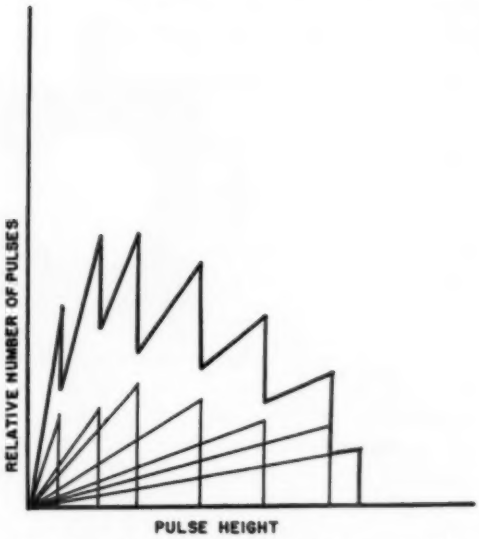

Fig. 2. Pulse spectrum produced by superposition of a number of discrete components. Each component is contributed by particles of fixed specific ionization.

In order to assess the specific ionization of the particles crossing the cavity, it is

necessary that the atmosphere be so tenuous that even for a path along a maximum diameter the total loss of particle energy is small. In this case the total number of collisions is reduced and effects of small-angle scattering which might lead to curvature of the trajectory are also lessened.

biological structures in which there is more variability. In general, however, considerations of specific ionization effects are limited to dimensions great enough that such variations are negligible.

Since both scattering and the statistical variations just discussed are much less

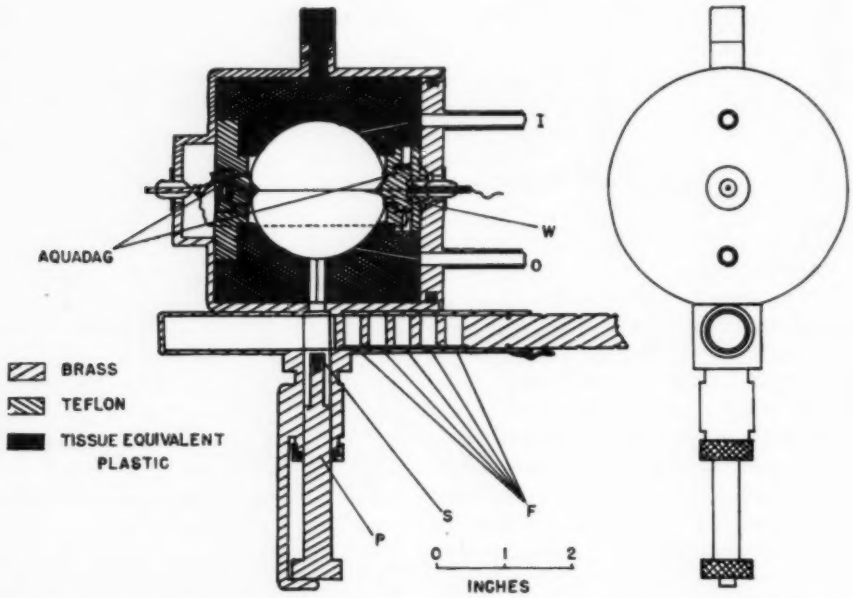

Fig. 3. Spherical proportional counter. I and O. Inlet and outlet for methane. W. 0.005 stainless steel wire. F. Aluminum absorbers. S. Alpha source. P. Plunger. The aquadaged surfaces act as correcting electrodes.

On the other hand, as the section of track under examination is shortened, there will be an increase in statistical variation. This may be due to fluctuations in the total number of primary ions produced or to differences in the energy expended in primary ionizations, the so-called Landau (3) effect,[2] the latter of these being more important. Consequently there will be an increasing spread in the apparent range of specific ionization of the particles as the size of the sample is decreased. The same considerations apply in an analysis of the process taking place in biological material, and, in effect, a cavity containing a small amount of gas will tend to duplicate small

serious in the case of positively charged nuclear recoils, initial work has been directed toward measurements involving these particles. Studies so far have been made utilizing internal alpha sources, and the experiments are about to be extended to secondaries produced by fast neutrons.

The counter constructed is shown in Figure 3. No attempt was made in this model to equalize absorption in all directions. This could obviously be accomplished by surrounding the cavity with a spherical shell of tissue-equivalent plastic instead of forming the spherical cavity in a cylindrical block of this material.

The requirement of true proportionality can be met only with a uniform electric field near the surface of the wire. With a

[2] The authors are indebted to Dr. U. Fano for bringing this point to their attention.

cylindrical wire in a spherical shell, this necessitates a very large ratio of sphere radius to wire radius. Initial computations have indicated that for the device to be practical for neutron fluxes in the range of the permissible limit, the diameter of the spherical cavity should be several inches.

In the model shown in Figure 3 the diameter is 2 inches. The wire diameter is 0.005 inches, which is about as small as practical. Measurements in an electrolytic tank model as well as actual performance data with an internal alpha source (see below) have indicated that, even with this ratio, a satisfactory field distribution can be obtained only at low gas multiplication. In this situation most of the multiplication occurs within a cylinder which is not much bigger than the wire and the field is reasonably uniform. Even in this case a correcting field improves matters and the cylindrical electrodes, when placed at appropriate voltages, improve the field distribution somewhat. Since it is planned ultimately to employ the instrument over a wide range of specific ionizations, low gas multiplication will be mandatory if proportionality is to be achieved over the entire range. For this reason not too much difficulty is anticipated due to the field distribution. A design is contemplated, however, in which the shell is laminated, providing closer control of the field distribution.

The total area subtended by the insulating surfaces is about 12 per cent. To minimize the erroneous response due to the Teflon used at present, insulators of polystyrene and polyethylene will be used in neutron measurements.

A plutonium source (S) on a plunger (P) may either be withdrawn (as shown in Fig. 3) and foils (F) of various thickness interposed, or the source may be pushed forward so as to be flush with the inside surface. In this case, which represents an extremely *non*-uniform radiation field, the pulse spectrum must be expected to be rectangular (Equation 3, Appendix).

To insure gas purity, a steady stream of methane is passed through the counter (from I to O). By means of a "manostat," the pressure is kept at constant levels of the order of 3 cm. The pulses are amplified by a linear amplifier (4), sorted by a differential analyzer, and observed on a scaler. The spectrum may be obtained by an automatic recording system that prints the elapsed time for a predetermined number of counts and advances the bias control of the discriminator in equal steps. It is planned to employ a multichannel analyzer in future work.

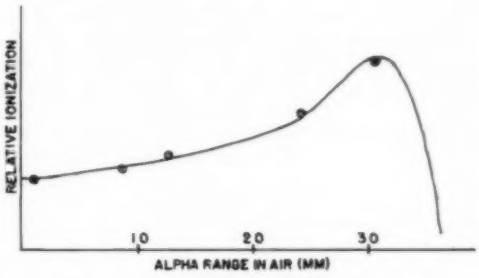

Fig. 4. Comparison of Bragg curve and pulse heights obtained by interposition of aluminum foils.

Checks on the performance of the instrument have thus far been made only with the internal alpha source. In one kind of test the alpha source has been withdrawn and foils of various thickness interposed. In this case the high degree of collimation limits the length of the trajectory to the one of a major sphere diameter. The pulse height should be proportional to $(-dE/dx)$ of alpha particles of the residual energy attained after foil traversal. This may be checked against values in the literature (5). This experiment serves to check the linearity of the entire system for pulses produced near the wire center. The result is given in Figure 4. The agreement is satisfactory within the range tested.

To check uniform multiplication along the wire, the source is collimated to produce a pencil of alpha rays at an angle of about 30° with the axis of the plunger. Rotation of the plunger permits variation of the azimuth of the beam axis. When the particles are in the plane of Figure 3, multiplication takes place along the entire

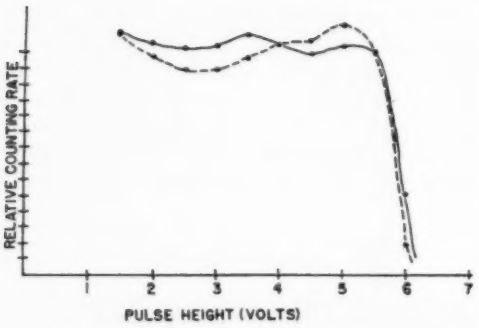

Fig. 5. Pulse spectrum obtained with alpha source positioned at inside surface of counter. Broken and solid curves show effect of 0 and 40 volts applied to correcting electrodes.

length of the wire. If the beam travels in a plane that is at right angles to the plane of the figure, all collection occurs near the center of the wire. The variation observed is of the order of 10 per cent.

Figure 5 shows the pulse spectrum obtained with the alpha source at the counter surface with the counter operated at 900 volts. The spectrum obtained differs from the rectangular shape which should be obtained under ideal conditions. The finite slope at the end is doubtless due to straggling. With the field adjusting electrode grounded (broken curve) a variation of ±15 per cent about the plateau value is observed. That this is mostly due to non-uniformity of the field is shown by the fact that application of a small correcting voltage (40 volts) modifies the spectrum markedly and reduces the variations to ±6 per cent. A laminated shell with a series of voltages may be expected to improve matters still more. Further tests are planned in which the position of the source inside the counter will be changed.

In conclusion, it may be said that experimental work performed so far indicates that a practical device meeting the theoretical requirements can be built and that the method could be used at least for evaluations in radiation fields producing protons or heavier ionizing particles in tissue.

APPENDIX

It is desired to find the path-length distribution of rays due to a point source through a spherical volume as a function of the pertinent parameters. Consider

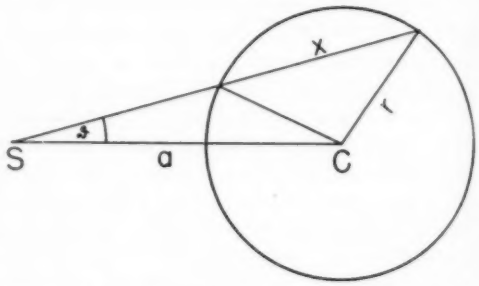

Fig. 6. Geometry of point source at distance a from center of spherical cavity of radius r.

Figure 6. The source is located at S, the center of the sphere at C, and the path length in the sphere of a ray given off at an angle ϑ is x. It can be shown that the following relationship holds between x, ϑ, r, and a:

$$\cos\vartheta = \sqrt{1-\left(\frac{r}{a}\right)^2\left[1-\left(\frac{x}{2r}\right)^2\right]}$$

Furthermore, the number of rays lying within the solid angle defined by the interval $(\vartheta, d\vartheta)$ is proportional to $\sin\vartheta\, d\vartheta$. The expression for this, in terms of x and the parameters, is obtained by differentiating the equation for $\cos\vartheta$, thus,

$$-\sin\vartheta\, d\vartheta = \frac{\left(\frac{r}{2a}\right)^2 x\, dx}{\sqrt{1-\left(\frac{r}{a}\right)^2\left[1-\left(\frac{x}{2r}\right)^2\right]}}$$

The above, then, is proportional to the sought after path-length distribution, $P(x)$. The normalized distribution is given by the following:

$$P(x) = \frac{x}{\sqrt{1-\left(\frac{r}{a}\right)^2\left[1-\left(\frac{x}{2r}\right)^2\right]}\int_0^{2r}\frac{x\,dx}{\sqrt{1-\left(\frac{r}{a}\right)^2\left[1-\left(\frac{x}{2r}\right)^2\right]}}} \qquad (1)$$

Two particular cases are of interest: (1) when the source is located at a great distance, $a \gg r$; (2) when the source is located at the surface of the sphere, $a = r$.

(1) For $a \gg r$, Equation 1 yields

$$P(x) = \frac{x}{\int_0^{2r} x\,dx} = \frac{x}{2r^2} \qquad (2)$$

This is a triangular spectrum.

(2) For $a = r$, Equation 1 yields

$$P(x) = \frac{x}{\frac{x}{2r}\int_0^{2r} 2r\,dx} = \frac{1}{2r} \tag{3}$$

In this case, the spectrum is rectangular.

For measuring the dose rate as a function of specific ionization in a spherical proportional counter, cavity by particles of a given specific ionization $(\sigma, d\sigma)$, consider, again, the pulse-height spectrum, Equation 4. The number of pulses in the interval (h, dh) crossing the cavity per second is $P(h)\,dh$. Hence, the dose rate (ergs/sec.) delivered by the particles of a single specific ionization $(\sigma, d\sigma)$ and pulse height (h, dh) is given by

$$dD(\sigma)\,d\sigma = KP(h)\,dh \tag{7}$$

where K relates the pulse height with the number

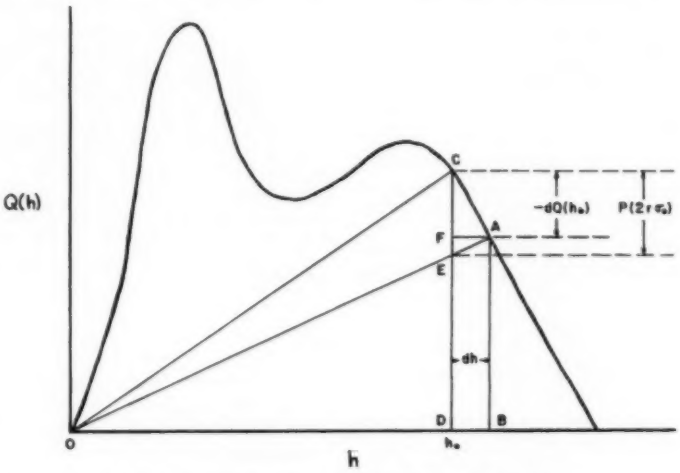

Fig. 7. Analysis of pulse-height distribution spectrum.

Case 1, Equation 2, above, is of importance. The expression for the pulse-height spectrum, $P(h)$, for particles of a single specific ionization, is obtained from Equation 2 by letting the pulse height, h, equal the product of the specific ionization and the path length, σx. Thus,

$$P(h) = \frac{h}{2r^2\sigma^2} F(\sigma)\,d\sigma \tag{4}$$

where $F(\sigma)\,d\sigma$ is equal to the number of particles, of specific ionization lying in the interval $(\sigma, d\sigma)$, crossing the counter per second, and $P(h)$ is normalized to the extent that

$$\int_0^{2r\sigma} P(h)\,dh = F(\sigma)\,d\sigma \tag{5}$$

where, $2r\sigma$ = maximum pulse height, *i.e.*, that due to particles crossing a major diameter. The resultant spectrum for a given specific ionization $(\sigma, d\sigma)$ is a triangle from which the following relationships can be derived:

$$\begin{aligned}\text{Area under the curve} &= \int_0^{2r\sigma} P(h)\,dh = F(\sigma)\,d\sigma \\ &= {}^1/_2\,(\text{base} \times \text{altitude}) \\ &= r\sigma P(2r\sigma)\end{aligned}$$

$$\text{Therefore, } F(\sigma)\,d\sigma = r\sigma P(2r\sigma) \tag{6}$$

To obtain the dose delivered to the spherical

of ergs per pulse deposited in the chamber. By Equation 4, then,

$$\begin{aligned}dD(\sigma)\,d\sigma &= \frac{KF(\sigma)\,d\sigma h^2\,dh}{2r^2\sigma^2} \\ D(\sigma)\,d\sigma &= \frac{KF(\sigma)\,d\sigma}{2r^2\sigma^2}\int_0^{2r\sigma} h^2\,dh \\ &= {}^4/_3\,Kr\sigma F(\sigma)\,d\sigma\end{aligned} \tag{8}$$

Equation 8 is the expression for the dose rate in ergs/sec. delivered to the whole counter by particles of specific ionization $(\sigma, d\sigma)$.

To obtain the dose rate as a function of specific ionization, consider now a pulse-height spectrum, $Q(h)$ which is due to a flux distribution, $F(\sigma)$, of particles of varying specific ionization. Such a distribution is given in Figure 7 and has the following properties: The pulse-height distribution, $Q(h)$, is made up of a continuous distribution of basic triangular spectra, triangle OAB is the sum of the heights, at $h = h_0 + dh$, of the fundamental triangles for which $2r\sigma > h_0$. Triangle OCD is the sum of the heights, at $h = h_0$, of the triangles for which $2r\sigma \geqslant h_0$. Therefore, the length $\overline{CE} = P(2r\sigma_0)$, *i.e.*, the altitude of the triangle for which $2r\sigma = h_0$. $\overline{CE} = \overline{CF} + \overline{FE}$, where $CF = -dQ(h_0)$, and $\overline{FE} = [Q(h_0)/h_0]\,dh$, which is obtained from the

similarity of triangles OAB and AEF. Therefore, in general:

$$-dQ(h) = P(2r\sigma) - \frac{Q(h)}{h}\,dh \qquad (9)$$

$D(\sigma)\,d\sigma$ in terms of the observed pulse-height spectrum and the specific ionization is derived by eliminating $P(2r\sigma)$ and $F(\sigma)\,d\sigma$ from Equations 6, 8, and 9, and noting that $dh/h = d\sigma/\sigma$. This yields

$$D(\sigma)\,d\sigma = {}^4/_3\,Kr^2\,[-\sigma^2\,dQ(h) + Q(h)\sigma\,d\sigma] \qquad (10)$$

The quantity of physical interest is actually the dose rate, $D_{12} = \int_{\sigma_1}^{\sigma_2} D(\sigma)\,d\sigma$, which is that due to particles within a finite range of specific ionizations, from σ_1 to σ_2. This is obtained by integrating Equation 10, yielding

$$D_{12} = {}^4/_3\,Kr^2\,[\sigma_1^2 Q(2r\sigma_1) - \sigma_2^2\,Q(2r\sigma_2) + 3\int_{\sigma_1}^{\sigma_2} Q(h)\sigma\,d\sigma] \qquad (11)$$

ACKNOWLEDGMENTS: The authors wish to express their indebtedness to Dr. G. Failla for frequent helpful discussions. A number of researchers have greatly assisted in various phases of this work. Among them are Mr. B. Dwork, Mr. S. Talesnick, Mr. M. Lubert, and Mr. S. Krakauer. In the early phases of this work pulse-height analyses were performed by means of the Gray-wedge analyzer made available through the courtesy of Dr. J. B. H. Kuper and Mr. R. L. Chase of Brookhaven National Laboratory.

630 W. 168th St.,
New York 32, N. Y.

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SUMARIO

Aparato para la Medición de la Dosis Tejido como Función de la Yonización Específica

Los parámetros físicos que determinan el efecto biológico de la irradiación yonizante son la energía llevada a los tejidos afectados y la densidad de yones a lo largo de las vías que siguen las partículas cargadas que producen los yones. En tanto que cabe determinar la primera por medio de cámaras de yonización debidamente diseñadas, la valoración de la última exige alguna especie de medición de las distintas partículas. Si se usa para ello un contador proporcional, se tropieza con la dificultad de que la yonización total producida depende tanto de la yonización específica de la partícula que atreviesa el volumen sensible como del largo de la vía que cruza dicha región. Por eso no puede ser exacta la distinción trazada entre partículas aun tratándose de yonizaciones específicas muy diversas.

Por otro lado, si se toma en cuenta el largo de la vía geométrica, debe ser posible diferenciar no tan sólo entre partículas yonizantes tan disímiles como son los electrones y las partículas alfa, sino también obtener un espectro total de la dosis entregada como función de la yonización específica. Si la cavidad del contador proporcional es esférica, cabe predecir la distribución de los largos de las vías para un número suficiente de transversales. Con tal que se cumplan ciertas condiciones, es por lo tanto posible eliminar los efectos geométricos. Descríbese y reprodúcese un contador proporcional del género mencionado.

DISCUSSION

John S. Laughlin, Ph.D. (New York): Dr. Rossi has described a method of relating the dose, as measured by a gas-filled chamber operating in the proportional region, to the specific ionization of the particles which produce this ionization. This method requires a knowledge of the distribution of the particle path lengths in the chamber, together with an analysis of their pulse heights. This is an ingenious method of correlating dose with specific ionization.

An experimental correlation of dose and specific ionization is very significant in view of the known dependence of the biological effectiveness of radiation on specific ionization. This is of

particular importance for heavy particles such as protons, neutrons, and the alpha particles for which this apparatus has been tested. In the range of specific ionizations of from 10 to 100 ion pairs per micron of water, produced primarily by either electrons directly or by the electrons energized in the x-ray absorption, the relative biological effectiveness is not believed to vary by more than a factor or two. However, above specific ionizations of 100 ion pairs per micron, which are produced by heavy particles, the relative biological effectiveness for many reactions markedly increases with increasing specific ionization. The radiobiologist is consequently almost as interested in a knowledge of specific ionization as he is in a knowledge of dose. Therefore, the further development of this apparatus should be of real utility to him.

In such an intricate experiment there are many problems, limitations, and details which have been fully treated by Dr. Rossi in his laboratory, though naturally they could not be described in the oral presentation. The mathematical development of the triangular path length distribution was for the case of primary particles. The assumption of the same distribution for the secondary particles imposes definite conditions on the chamber wall, such as a minimum thickness equal to the maximum range of the secondaries, and uniformity in any absorption of the primaries. These problems have been treated in detail in this development.

The further development and application of this method should be of real significance in radiobiological research.

Raymond E. Zirkle, Ph.D. (Chicago, Ill.): I am not entirely clear about the dimension of the cavity of the apparatus. How good a resolution can you get?

Dr. Rossi: The cavity has a diameter of 2 inches and is filled with methane at a pressure of 3 cm. of mercury. An ionizing particle traveling along a major diameter experiences about as much stopping as in traversing a millimeter of air under standard conditions. It would appear practical to lower the pressure to obtain still better resolution if necessary.

L. D. Marinelli, M.A. (Lemont, Ill.): Since experience has shown rather conclusively that many radiological effects depend on the rate of linear energy transfer, an instrument designed to provide this parameter directly is obviously most welcome, and Dr. Rossi should be congratulated on his achievement. His presentation of the correct determination of the Bragg curve from *thin* alpha sources is rather convincing. To my mind, however, there remains another proof to clinch the argument, namely the experimental verification of the specific ionization spectrum from a *thick* alpha source by means of "triangular" differentiation of the pulse-height spectrum.

Availability of an instrument of this type may have far reaching implications in the establishment of maximum permissible levels, since it may well permit their formulation in terms of dose and some "average" of specific ionization without reference to the ionizing particle. May I comment on the fact that testing apparatus such as this is becoming rather difficult, since sources of particles of various mass and energy are not readily available. In neutron dosimetry, for instance, any adequate testing of a new apparatus involves a pilgrimage to New Mexico. This situation is hardly conducive to rapid advancement in the field, but this seems to be the state of affairs with which many workers have to contend right now.

Device for the Control of Radiation Distribution in Moving Beam Therapy[1]

O. S. PETERSON, JR.,[2] J. C. FOLEY,[3] and R. F. MOSHER[4]

WHEN A PHYSICIAN implants radium or other radioactive material in tissues in the pelvis following a cycle of roentgen therapy, he is attempting to improve the distribution pattern of radiation or energy absorbed in certain specific areas. If we ask, what, from a physical standpoint, constitutes an approach to an ideal radiation technic, one of the answers may be stated as follows. It is the production within the body of three-dimensional isodose curves at some specific optimum level of dosage whose shape will closely approximate the shape of the particular tissue mass under treatment; the dosage within the mass outlined by such isodose curves shall be relatively uniform and of a high order of magnitude relative to dosage external to the mass. Although we cannot, strictly speaking, add up in r units and equivalents the tissue or integral dose from varying sources such as x-radiation and gamma emitters, none the less it is quite generally agreed that the type of radiation is of little particular importance, provided the distribution of energy absorption is satisfactory.

Howard Nielsen (1) and others (2) have plotted numerous isodose curves for rotational roentgen therapy in the medium-voltage range and have pointed out that, particularly in the pelvis, the shape of the curves and therefore the distribution from simple rotational or pendulum therapy alone is not satisfactory. Nielsen states: "Both the rotatory axis and the target axis distance are fixed." After careful consideration of all the factors affecting the shape of isodose curves within various portions of the body, including use of wedge filters and multiple positioning of the centers of rotational cycles, it becomes apparent that, if rotational therapy in the medium-voltage range is employed, variation of both the target-skin and target-tumor distance, together with variation of milliamperage or speed during the rotational cycle, must be accomplished in order to modify satisfactorily the distribution of the radiation. Thus, we may rotate a patient in a vertical or horizontal axis, concomitantly varying the target-skin distance, or we may keep the patient motionless while moving the radiation source through an irregular orbit about the tumor, and preferably in more than one plane. If we rotate the patient around a vertical axis, then the patient must sit up or stand erect lashed to some supporting framework. Not only is this an unpleasant and oftentimes a frightening procedure. but in many instances it may be prohibited by the physical condition of the patient. Organs, particularly in the abdomen and pelvis, assume different positions and relationships with the patient vertical than when he is prone or supine. Also, because of fatigue and relaxation, the relationship of organs may and probably will change even during the period of rotation. If the patient is rotated around a horizontal axis, then he also must be lashed to such apparatus, and the same objections relative to variation in position and relationship of soft organs hold true as for vertical rotation.

As is obvious from the above, it is far better that we have equipment capable of

[1] This project supported in part by National Institute of Health, Grant #CS-9214, the Vermont Cancer Society, Inc., and the Mary Fletcher Hospital, Burlington, Vt.
Paper accepted for publication in February1954.
[2] Associate Professor of Radiology, University of Vermont College of Medicine, and Radiologist, Mary Fletcher Hospital.
[3] Fellow in Radiology, University of Vermont College of Medicine, and Assistant Investigator, National Institute of Health, Grant #CS-9214.
[4] Associate Professor of Electrical Engineering, University of Vermont.

moving the radiation source through an irregular orbit about the patient, and preferably in more than one plane.

We believe that the various linear motions and adjustments ordinarily available in the conventional types of x-ray therapy equipment for single fixed-portal use should still be made available in equipment designed for rotational or moving beam therapy. By the use of proper controls, linear motions at right angles to each other, coupled with a means of rotating the source itself about its central point, can result in practically any type of irregular orbital motion desired.

The equipment we are at present constructing is suspended entirely from overhead supports. The accompanying figures taken from our original sketches will serve to illustrate the principles and mechanisms employed. Furthermore, they indicate how tube head supports now commonly used may be modified to provide for this type of orbital moving beam therapy.

Figure 1 is a diagrammatic representation of a conventional type of x-ray therapy tube stand. The tube head can rotate, usually in two planes, about a point located at its focal spot. This tube, mounted on its supporting carriage, can be moved horizontally back and forth along the supporting bars 31 and 32. Also, it is usually possible to move the tube in a horizontal direction at right angles to the above motion. The assembly 35–36, supporting the horizontal members, can be moved vertically up and down columns 38 and 40. By proper continual variation of speeds imparted to the vertical and horizontal linear motions, the tube may be made to

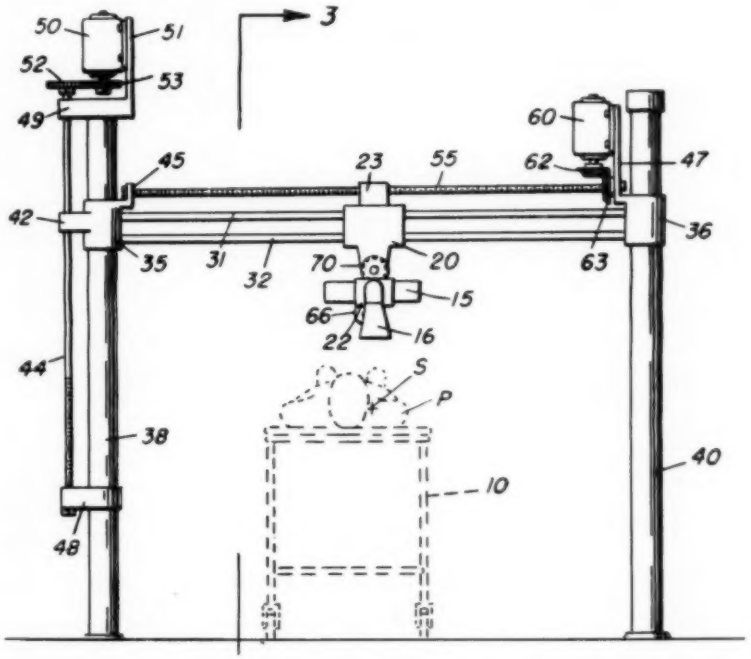

Fig. 1. Diagram of conventional type of x-ray therapy tube stand.
10. Treatment table or ordinary stretcher truck. 15. X-ray tube. 16. Cone. 20. Tube carriage. 22. Tube support. 23. Threaded lug to engage lead screw. 31, 32, 35, 36. Horizontal support assembly for tube carriage. 38, 40. Vertical support columns. 42. Threaded lug to engage lead screw. 44, 48, 49, 52. Vertical lead screw assembly. 45, 55, 63. Horizontal lead screw assembly. 50, 51, 53. Vertical drive motor with support and gear. 60, 62, 47. Horizontal drive motor with support and gear. 66. Portion of motor for translatory motion. 70. Drive motor and gear for angulation tube head. P. Patient. S. Center of mass or volume selected for irradiation.

follow an orbital path which may be either irregular in contour or resemble a segment of a circle. During this orbital motion the tube itself must be rotated in order to keep the collimated x-radiation beam constantly directed toward the point being treated.

Figure 2 illustrates the method we have employed to obtain the variable speeds necessary to maintain the tube in any particular orbital pathway. In this figure, 71 represents a base plate into which are machined two parallel slots, 72. Keyed into these slots is a sliding board, 75, whose motion controls the vertical motion up and down the vertical columns 38 and 40. Cut in this sliding board at right angles to the motion of the board itself is a slot, 76, and fitted into this is a shoe, which is fastened to a similar shoe by means of a pin or stub axle. This latter shoe moves back and forth in the slot cut in the radial bar pivoted at point 0.

Fixed to the base plate 71, is a Selsyn unit, 80. A cable attached to the sliding board 75 is affixed to a spring-loaded reel attached to the shaft of this Selsyn. Likewise, the pin through the two shoes, 105 and 108, is attached through a cable to a spring-loaded reel attached to the shaft of the Selsyn control 90. The radial arm 102 is fixed to the shaft of Selsyn control 100. A spring fixed to one end of the slot in the radial arm and at the other end to the pin or sliding shoe is for the purpose of keeping this pin and shoe pulled continuously toward point 0. The pin (supplied with a rotating collar or roller) rests at all times against some point on the contour of the template 85, which is cut to the shape of the particular orbital path desired. To simplify the mechanism, we plan to rotate the tube of this equipment through an arc of not more than 180° at any one session or cycle.

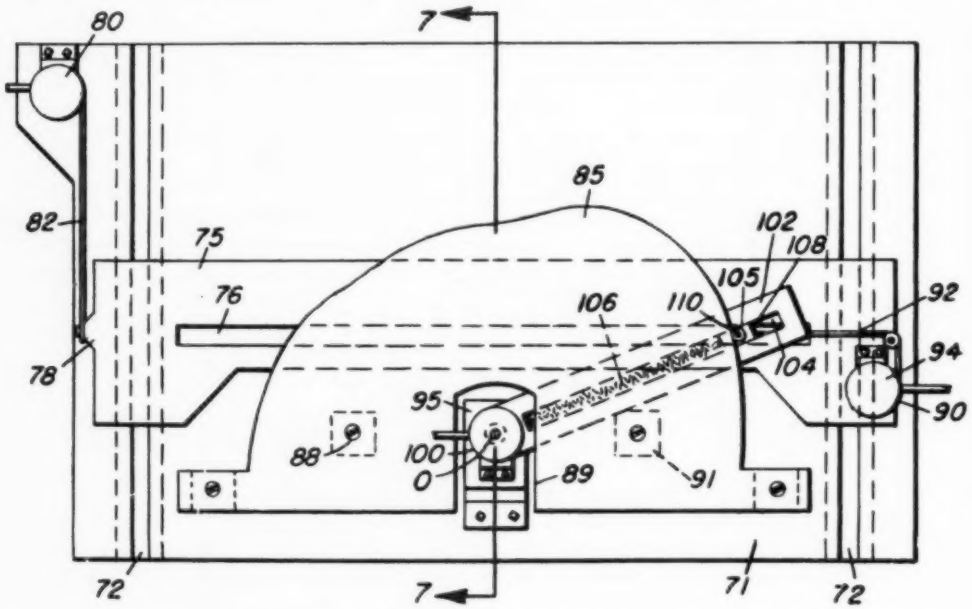

Fig. 2. Method for obtaining variable speeds necessary to maintain x-ray tube in desired orbital pathway. 0. Shaft of Selsyn and center of orbital rotation. 71. Base plate. 72. Slots for sliding board. 75. Sliding board to determine vertical component of motion. 76. Slot for sliding shoe. 78. Stud for attaching cable. 80. Selsyn assembly to reflect vertical component of motion. 82. Cable. 85. Template to determine shape of orbit. 88, 91. Studs and screws for mounting template. 89. Opening in template to accommodate Selsyn assembly. 90, 94. Selsyn and reel to reflect horizontal component of motion. 92. Cable. 108. Attachment of cable to pin and shoe assembly. 95, 100. Selsyn assembly to control angulation of central beam. 102. Radial bar. 104. Slot in radial bar. 105, 110. Pin and shoe assembly. 106. Tension spring.

As can readily be seen, on rotation of the shaft which passes through the Selsyn 100 and to which the radial arm 102 is fixed, the pin 110 is forced to follow the contours of the template. As it does so, there is a resultant motion of the shoe and pin along the slot cut in the sliding board 75 as well as motion of this same board along the vertical path determined by the slots cut in the base plate.

These motions are, of course, accurately reflected in the angular motion of the shafts of the three Selsyn controls. These angular motions are then transmitted to the driving motors 50, 60, and 70, which are so geared as to result in proportionately corresponding linear motions along columns 38 and 40, across bars 31 and 32, and to impart angular motion to the beam of x-radiation emanating from the x-ray tube.

Thus, we have a means whereby we can rotate the source of radiation through an irregular orbit, which is only another way of saying that we can rotate a source of radiation about the patient while continually varying the tumor- or skin-target distance. Rather than attempt to vary the angular speed of rotation, we plan to vary the milliamperage supplied to the tube.

To our knowledge, no satisfactory method of tumor dose calculation has as yet been evolved for this type of moving beam therapy, where the radiation source follows an irregular orbital path. It is our intention first to resort to direct measurements in presdwood phantoms. We are employing not only an infinite type of phantom, but also finite phantoms in anatomical shapes. These phantoms are being equipped with accessories to provide for photographic film studies of radiation intensities within the phantom as well as provisions for placement of small r meter chambers in a multitude of positions. Using a number of these miniature r chambers we will be able to provide for simultaneous readings at various locations. These midget type chambers will be constantly checked against a master Victoreen chamber, and frequently against a radium source both in air and in phantoms.

However, since we are working in the 250-kvp range, more important in the final analysis will be phantoms simulating various anatomical regions not only in shape but in densities. The first such one to be constructed is a simulated pelvis together with upper femora and lower lumbar spine. The pelvic and lower abdominal cavities will be filled with some suitable granular material to allow for placement of the midget chambers in various locations. Provision will also be made for film studies.

SUMMARY

Equipment has been described which allows the use of continually variable target-tumor distances during rotational or moving beam therapy. It is hoped that this may make the use of moving beams in the medium-voltage range more effective and more feasible, by providing a mechanism capable of producing the desired distribution of radiation within the pelvis or elsewhere during a single automatically controlled cycle of orbital motion.

The apparatus is very flexible and, although we have considered here only the employment of orbital movement with the beam centered to a point, it is possible, with minor alteration of the simple control mechanism illustrated (change in diameter of reel 94, Fig. 2), to obtain moving-beam therapy with a continually varying center of rotation in order to modify further the isodose curve shape, this being merely an extension of the concept or maneuver of employing pendulum therapy about two or more centers of rotation.

The patient may be treated on an ordinary table or truck in a comfortable supine, prone, or other horizontal position.

There is no interference with the conventional straight-line and rotary motions of the tube head, so useful when positioning for fixed-source irradiation.

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SUMARIO

Gobierno de las Curvas de Isodosis en la Terapéutica de Haces Movibles

Descríbese una instalación que permite usar distancias foco-tumor constantemente variables durante la terapéutica rotatoria o de haces movibles. Espérase que esto haga más eficaz y más factible el uso del haz movible en la escala de voltaje medio, por aportar un mecanismo capaz de producir la distribución buscada de radiación dentro de la pelvis o en otro sitio durante un solo ciclo automáticamente regido de movimiento orbitario.

El aparato es muy flexible, y aunque no se considera aquí más que el empleo de movimiento orbitario, con el haz centrado en un punto, es posible, con pequeñas modificaciones del sencillo mecanismo de gobierno reproducido, obtener terapéutica de haces movibles con un centro de rotación que varía continuamente a fin de modificar más la forma de la curva de isodosis, siendo esto meramente una extensión del concepto o maniobra de emplear terapéutica oscilante alrededor de dos o más centros de rotación.

El enfermo puede ser tratado en una mesa o carretilla ordinaria en cómoda posición supina, prona u otra horizontal. No obstaculiza esto los acostumbrados movimientos en línea recta y rotativos de la cabeza del tubo, que son tan útiles al determinar la posición para la irradiación con foco fijo.

The Recognition of Air in Diverticula of the Colon as a Diagnostic Aid[1]

PAUL MASSIK, M.D., and FRANK E. WHEATLEY, JR., M.D.

DIVERTICULA OF the colon are generally demonstrated by barium enema, but many cases of diverticulosis and diverticulitis are undoubtedly overlooked because of vague and misleading symptoms and their faulty interpretation.

At our hospitals, anteroposterior scout films of the abdomen are routinely obtained on all patients undergoing Graham tests, pyelography, or barium studies. In several cases we have noted collections of air suggesting air-filled diverticula along the course of the lower colon on these scout films, and barium enema studies have confirmed this diagnosis.

The air-filled diverticula present a "bubbly" appearance, *i.e.*, an area of slightly increased density interspersed with rounded spots of radiolucency. They are usually located in the left lower quadrant, most frequently in the pelvis, and occasionally they "string out" in a line. The appearance is quite characteristic and easily recognized when sought. In but few cases in which we have observed this sign did a subsequent barium enema examination fail to show diverticula at the spot suspected.

Since scout films of the abdomen are routinely taken for many reasons, we feel that as careful a search for air pockets should be made as for calculi or space-occupying masses.

Over a nine-month period, during which time 370 barium enemas were performed, air-filled diverticula were noted in 12 cases; 6 at the Goddard Hospital, where 207 barium enemas were performed, and 6 at the Milton Hospital, where 163 barium enemas were done. If less characteristic cases were to be included, the incidence of demonstrable air-filled diverticula would probably be considerably higher.

Fig. 1. Case I. Air-filled diverticula demonstrated on scout film (A and B) and confirmed by barium enema examination (C).

CASE I: Mrs. A. E., age 75, was admitted to the hospital Jan. 7, 1952, because of "crampy" abdominal pains and constipation. Physical examination showed a moderately distended abdomen and hyperperistalsis. A scout film of the abdomen revealed numerous small pockets of air in the region of the sigmoid, consistent with diverticula. A barium enema examination confirmed the presence of diverticula. Treatment was conservative and the patient was discharged from the hospital improved.

CASE II: Mrs. C. K., age 65, was admitted to the hospital, complaining of tenesmus with diarrhea. Physical examination was negative except for a palpable bowel. A scout film of the abdomen showed numerous small pockets of air in the region of the sigmoid, and a barium enema study confirmed the presence of diverticula.

[1] From the Goddard Hospital, Brockton, Mass., and Milton Hospital, Milton, Mass. Accepted for publication in January 1954.

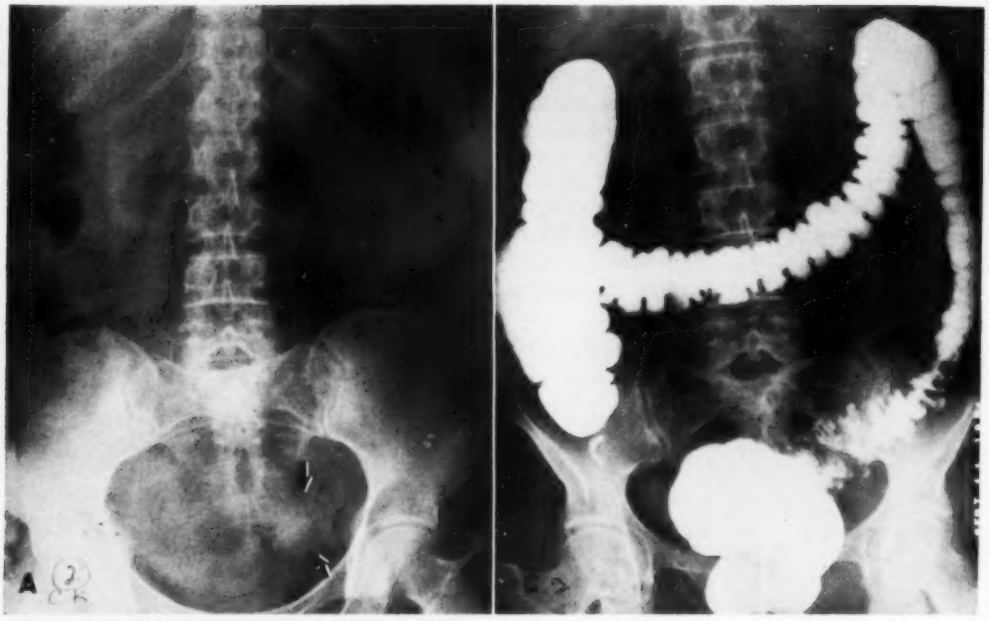

Fig. 2. Case II. A. Scout film showing air-filled diverticula in the left pelvis (between the arrows). B. Enlargement of A. C. Barium enema study.

The patient was treated medically and was discharged, improved, without surgery.

SUMMARY

1. During a nine-month period, in which 370 barium enemas were done, air in colonic diverticula was recognized on the anteroposterior scout film of the abdomen in 12 cases.

2. As careful a search should be made for air-filled diverticula on the routine scout film of the abdomen as for abnormal masses, enlarged viscera, or calculi, since discovery of such air pockets may be a clue toward establishing a correct diagnosis.

67 Coddington St.
Quincy 69, Mass.

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SUMARIO

El Descubrimiento de Aire en los Divertículos del Colon como Auxiliar Diagnóstico

En las radiografías exploradoras corrientes del abdomen, la busca de divertículos debe ser tan cuidadosa como la de tumefacciones anómalas, cálculos o esplacnomegalia. Los divertículos henchidos de aire aparecen en forma de zonas ligeramente más espesas entremezcladas con puntos redondos de radiolucencia, por lo general en la fosa ilíaca izquierda. El examen con enema de bario confirmará el diagnóstico.

Durante un período de nueve meses, en el que se hicieron 370 estudios con enema de bario, en 12 casos se reconoció el aire de los divertículos colónicos en la radiografía exploradora del abdomen. Ofrécense dos ejemplos.

Stellate Fissuring in Gallstones[1]

J. J. CANCELMO, M.D.

STELLATE cavities within the centers of gallstones have been known for many years, but only recently have we come to realize that these cavities may contain gas (1–3). The literature on this subject has recently been thoroughly reviewed (3, 4). Schwarz was able to collect 12 cases, to which he added one of his own. Since Hinkel's original report of 1 case (3) he has discovered another half dozen (5).

It is the purpose of this paper to report 3 additional examples of fissuring in gallstones. It was possible to make the diagnosis of cholelithiasis in the first case only because of these fissures, since the stones themselves were not visible.

CASE REPORTS

CASE I: E. F., a 34-year-old housewife with a history of fatty food intolerance, experienced within a period of six months three acute attacks of right upper quadrant pain radiating to the right scapula, accompanied by nausea and vomiting. Cholecystography revealed several stellate radiolucent shadows overlying the faintly visualized gallbladder. Though no stones could be definitely seen, it was thought that these stellate shadows represented gas-filled fissures within the centers of gallstones (Fig. 1). The x-ray diagnosis was partially functioning gallbladder with cholelithiasis, and cholecystectomy was performed. The pathological diagnosis was chronic calculous cholecystitis. A roentgenogram of the stones demonstrated the stellate fissures which were seen on the cholecystogram (Fig. 2).

Comment: In this case the stones were of the same density as the faintly visualized gallbladder and were recognizable on the roentgenograms only because they contained radiolucent fissures. An earlier cholecystogram obtained elsewhere had been interpreted as showing nothing more than a moderate impairment of function. The patient was only thirty-four years old and the referring physician wanted to be absolutely certain that she had gallbladder disease before submitting her to surgery. Because of the visualization of the stellate fissures a definite diagnosis of cholelithiasis could be made.

Fig. 1. Case I. Magnified view of right upper quadrant, revealing faint gallbladder shadow. Note the small stellate radiolucent shadows lying just beneath the 11th rib.

CASE II: F. O., a 59-year-old obese female, with hypertension, gave a history of dyspepsia and intolerance for fried and fatty foods. Marked tenderness was elicited on palpation of the right upper quadrant. On cholecystograms the gallbladder shadow was barely visible. Within its lumen was a single large stellate radiolucent shadow and the presence of one or more non-opaque calculi was suggested (Fig. 3). The roentgen diagnosis was marked impairment of function with cholelithiasis, and cholecystectomy was performed. The pathological diagnosis was chronic calculous cholecystitis. A film of the unopened gallbladder beautifully demonstrated the fissuring phenomenon (Fig. 4).

Comment: That the gallbladder was diseased was obvious from the marked impairment of function. We would have been uncertain as to the presence of calculi, however, had it not been for the fissuring phenomenon.

[1] From Coatesville Hospital, Coatesville, Penna. Accepted for publication in March 1954.

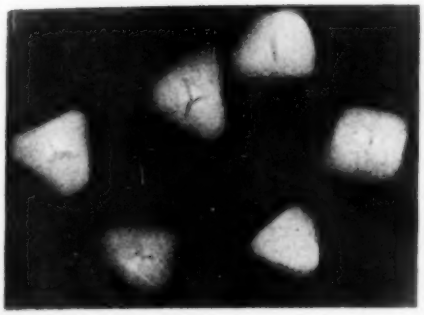

Fig. 2. Case I. Roentgenogram of removed gallstones, clearly demonstrating the fissuring phenomenon.

CASE III: A. R., a 35-year-old white female, gave a history of indigestion and pain in the right upper quadrant of several weeks duration. Cholecystography revealed two stellate radiolucent shadows in the right upper quadrant of the abdomen just below the twelfth rib (Fig. 5). The gallbladder could not be visualized with certainty. The roentgen diagnosis was non-functioning gallbladder with cholelithiasis. A gastrointestinal examination done the following day clearly demonstrated one of the stellate fissures (Fig. 6). Cholecystectomy was performed. A film of the unopened gallbladder shows the fissures within the gallstones (Fig. 7). The pathological diagnosis was calculous cholecystitis.

Comment: This patient also had an obviously diseased gallbladder, but again a definite diagnosis of cholelithiasis could not have been made had it not been for demonstration of the radiolucent fissures.

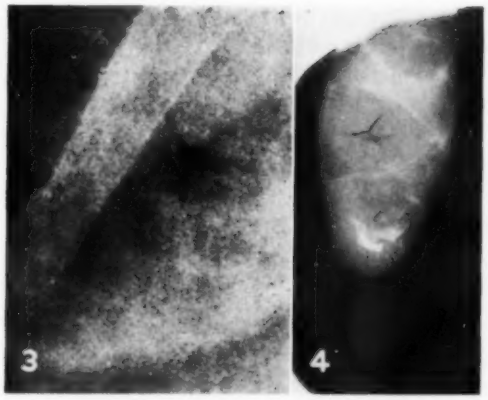

Fig. 3. Case II. Magnified view of right upper quadrant, revealing a large stellate radiolucent shadow lying beneath rib. Gallbladder shadow not visualized with certainty.

Fig. 4. Case II. Film of unopened gallbladder following its removal, demonstrating fissure within the center of a large gallstone and the presence of several other stones.

DIFFERENTIAL DIAGNOSIS

The majority of stones which show the fissuring phenomenon are of the cholesterol variety (5). They are usually non-opaque but may be faintly visualized if they contain a small amount of calcium.

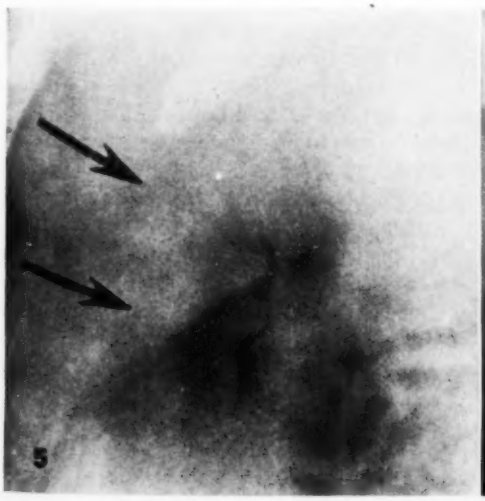

Fig. 5. Case III. Magnified view of right upper quadrant. Gallbladder not visualized. Arrows point to two stellate radiolucent shadows.

Fig. 6. Case III. Magnified view of duodenal cap and vicinity. Cap on left; stellate radiolucency on right.

The fissures are rather characteristic in appearance and once they have been seen, there is little difficulty in identifying them on the roentgenogram. We recently saw a case in which we made a diagnosis of cholelithiasis on the basis of what we believed to be fissures in the centers of gallstones, though these did not have the typical stellate appearance but were linear and irregular in character. Although gallstones were found at operation, a film of the specimen showed no fissuring. Apparently the radiolucent areas represented dead spaces between numerous closely packed calculi.

Fig. 7. Case III. Film of unopened gallbladder following its removal, demonstrating a fissure within each gallstone.

In our first case the stellate radiolucent shadows measured 8 mm. in their greatest diameter, in the second case 15 mm., and in the third case 10 mm. A second source of error occurs in the presence of very faint, and much smaller, radiolucent stellate shadows in the gallbladder region, measuring 2 or 3 mm. in diameter. These are seen quite frequently if one uses a magnifying glass in viewing the films. We are uncertain as to their cause but we suspect that they are due to overlying soft tissue or, more likely, to the grain in the film emulsion. Inasmuch as these shadows can also be seen outside of the gallbladder, they should not be a cause for confusion.

Schwarz quotes a single case in which air trapped in the umbilicus produced a stellate radiolucency on a radiograph of the abdomen. This possibility, although remote, is a third potential source of error in interpretation. Overlying gas shadows in the small or large bowel should not be confusing in the majority of cases.

DISCUSSION

In an effort to demonstrate gas within the fissures of these gallstones we repeated the condom experiment of Hinkel, using the stones secured from the first case. A rubber condom was filled with warm mineral oil and one or more gallstones and was tied off so that no air bubbles remained in the oil. The stones were then broken with a hammer and gas bubbles were seen to arise from them.

SUMMARY

Three cases of fissuring in gallstones are presented. This phenomenon is of more than academic interest, sometimes serving as the sole basis for a diagnosis of cholelithiasis, as in one of the cases recorded here.

The fissures are usually easily recognizable on the roentgenogram as stellate areas of radiolucency. Sources of possible confusion are linear radiolucent shadows presumably due to dead spaces between closely packed gallstones; small radiolucent shadows attributable to overlying soft tissue or possibly to the grain in the film emulsion; air trapped in the umbilicus, as reported by Schwarz.

The stones from the first case presented here were found to contain gas.

NOTE: The cases reported were from the surgical services of Dr. Ernest Williamson and Dr. William Bates, Presbyterian Hospital, Philadelphia, and Dr. John W. Pratt, Coatesville Hospital, Coatesville, Penna. The author wishes to express his thanks for permission to present these reports.

Coatesville Hospital
Coatesville, Penna.

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SUMARIO

Fisuración Estrellada en los Cálculos Biliares

Preséntanse 3 casos de fisuras en cálculos biliares. Este fenómeno posee importancia no meramente teórica, pues sirve a veces de única base para un diagnóstico de colelitiasis, como en uno de los casos aquí descritos.

Las fisuras suelen ser fáciles de reconocer en la radiografía en forma de zonas estrelladas de radiolucencia. Posibles causas de confusión son las sombras lineales radiolucientes presuntamente debidas a espacios desvitalizados que separan cálculos muy apiñados; pequeñas sombras radiolucientes atribuíbles a tejido blando sobreyacente o posiblemente al grano de la emulsión de la película; aire atrapado en el ombligo, según apuntara Schwarz.

Los cálculos del primer caso descrito en este trabajo contenían, según se observó, gas.

A Pneumocolon Bottle[1]

LEE B. LUSTED, M.D., and EARL R. MILLER, M.D.

THE TWO-STAGE pneumocolon procedure, in which the patient must leave the fluoroscopy room, evacuate the barium, and return for the air study, has several disadvantages: (1) It involves loss of time. (2) The amount of barium evacuated before the air study cannot be regulated. (3) Accumulation of mucus in the colon or resorption of water from the contrast solution may cause the barium to clump on the bowel wall. All these difficulties are avoided by the one-stage examination.

The pneumocolon bottle[2] ("Bairbot") to be described here permits a barium-air contrast study of the colon to be performed in one stage. It is employed at the University of California whenever a double contrast enema study is done as a single procedure. The construction of the bottle is shown in Figure 1. The materials may be purchased for approximately one dollar, and the device can be assembled in less than one hour.

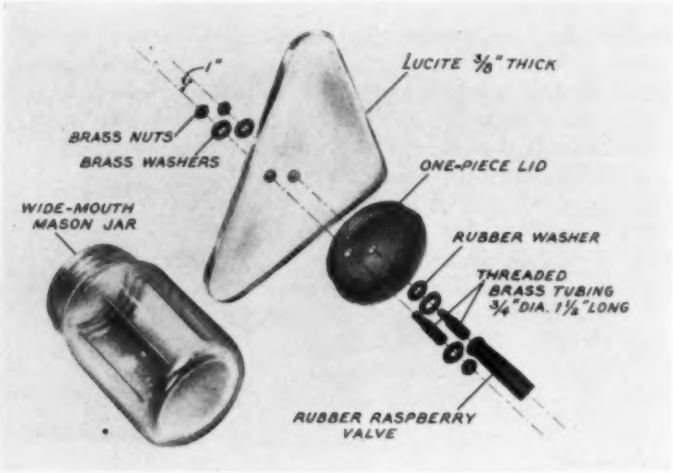

Fig. 1. Construction of pneumocolon bottle.

The procedure is as follows: The wide-mouthed jar is filled with a barium preparation; the lid is screwed on, and the bottle is placed on the fluoroscopy table, as shown in Figure 2. In Position I the triangular plastic support allows the jar to lie flat on the table top. Note that the enema tube opens below the fluid level. After the tip of the tube has been inserted in the rectum, the tubing clamp is removed, and the descending colon is filled with barium by squeezing the hand bulb.

The bottle is then rotated 120° (Fig. 3). The triangular plastic support elevates the top of the jar, and the enema tube now opens above the fluid level in the jar (Position II). Air enters the colon when the hand bulb is squeezed. If more barium solution is needed during the procedure, the bottle is returned to Position I. The radiologist is able to identify the bottle position in the dark, because only in Position II will he be able to slip his fingers between the bottle and the table top.

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[1] Presented as an exhibit at the Thirty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 13–18, 1953. Accepted for publication in February 1954.

[2] May be obtained from Barnes-Hind Barium Products Co., San Francisco, Calif.

Fig. 2 (left). Pneumocolon bottle assembled and connected to rectal tube. Barium is instilled in this position (Position I).
Fig. 3 (right). Bottle has been rotated 120° from Position I. Air is instilled in this position (Position II).

Reflux of barium into the bottle is prevented by the positive pressure within the bottle. A rubber valve[3] prevents the flow of barium solution into the hand bulb.

The device may be washed easily and, when necessary, any of the parts may be readily replaced.

[3] The valve used in this device is a toy known as a rubber "raspberry," "Bronx cheer," etc. It can be obtained in novelty and dime stores.

SUMMARY

A pneumocolon bottle made from a wide-mouthed Mason jar, threaded brass tubes, and a rubber "raspberry" valve, permits a barium-air contrast study of the colon to be made easily in one stage. The device is inexpensive to make, simple to use, and easy to fill and clean.

University of California Medical Center
San Francisco 22, Calif.

SUMARIO

Frasco para Neumocolon

Descríbese un frasco para neumocolon que permite realizar fácilmente y en un solo tiempo el estudio del colon con contraste de bario y aire, ahorrando así tiempo y eliminando otras desventajas del procedimiento en dos tiempos. El frasco es de construcción sencilla, sin que se necesite más que un bocal de vidrio de los de Mason, tubos enroscados de latón, una válvula de caucho y un soporte triangular de plástico. Es poco costoso construirlo, sencillo usarlo y fácil llenarlo y limpiarlo.

A New Roll-Film Dryer[1]

ISRAEL STEINBERG, M.D., BERNARD K. RYAN, R.T., and JOHN A. EVANS, M.D.

ROLL FILM HAS become an established feature of serial roentgenography (1–3). Developing, fixing, and washing have been relatively simple with the Fairchild-Smith motor-driven x-ray roll-film processing unit. Drying, however, because of the length of the film, up to 75 feet, has been difficult, requiring careful hanging and separation to prevent sticking (4). Standard hot-air dryers are ill suited for this purpose because of the long time required for the drying, and the necessity of draping and looping of the roll film, demanding constant attention to prevent scratching and falling. Recently, a new drying apparatus has been made available.[2]

MECHANISM OF DRYER

Parts: The dryer is sturdily constructed of stainless steel and built to process films of varying widths up to 12 inches. Essentially, it is of simple design, consisting of four main parts: a 1/3-horse-power, 60-cycle, 115-volt motor; a spring-type 60-minute timer; three 15-ampere coil heater units; and two fans.

The motor has a dual purpose: it provides, through a gear arrangement, transport of the film and furnishes the power for the twin fans. The blowers are arranged on either side, and a baffle forces jets of warmed air to circulate on both sides of the film. Hot air is generated by the three heating units located at the bottom of the dryer. The timer can be pre-set for the estimated drying period and automatically shuts the unit off.

Operation: The operation is simple. The Fairchild-Smith processing x-ray roll film developing device is attached to the dryer (Fig. 1). The "leader edge" is detached from the reel and is drawn by hand into the drying chamber. The dryer is then turned "on." The loading strip is allowed to dry, which usually takes half a minute. It is then attached to the "take-up" spool with a strip of adhesive (Fig. 2). The timer is set according to the length of film to be dried. For a full 75-foot roll at a speed of 22 inches per minute, the drying time is fifty minutes. In case of excessive humidity, the speed of film transport may be slowed. There are four speeds, with a maximum of 22 inches per minute. Adjustment to the desired rate of film transport may be had by pre-setting the lever drive at the clutch.

DISCUSSION

The roll-film dryer herein described has had constant use during the past year. A total of 150 rolls of film of approximately 75 feet each have been processed. Film varying from 9 1/2 to 12 inches has been used without mechanical difficulties. Because of the compactness of the unit (25 × 25 × 20 inches), it occupies only a small corner of the dark room. Considerable time has been saved in the actual film drying period and, more important, the automatic feature obviates the need of attention. In no instance was there failure to secure a dry, finished, and unmarred product.

SUMMARY AND CONCLUSION

A new automatic roll-film dryer is here described. It has had a year's trial at the New York Hospital-Cornell Medical Center and has proved singularly free of mechanical failures. It is commercially available[3] and in our hands has proved highly successful.

ACKNOWLEDGMENTS: Thanks are due to Hiram M. Bennett of the Fairchild Camera and Instrument Company for technical advice and to J. Wesley

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[1] From the Department of Radiology, The New York Hospital-Cornell Medical Center, New York, N. Y. Accepted for publication in March 1954.

[2] Courtesy Philadelphia Air Transport Company, Norristown, Penna.

[3] From the F. and R. Machine Works, Woodside, L. I., New York.

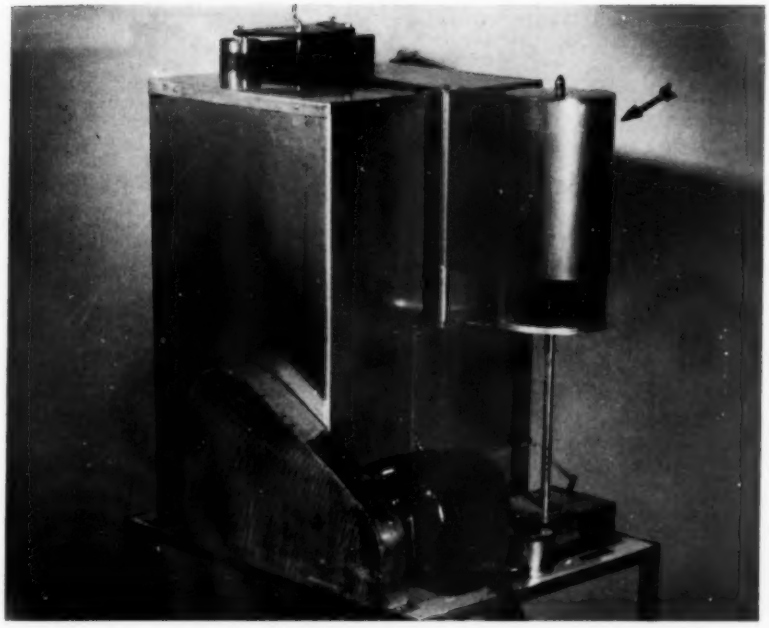

Fig. 1. Side view of dryer showing attached Fairchild-Smith roll-film processing device (arrow).

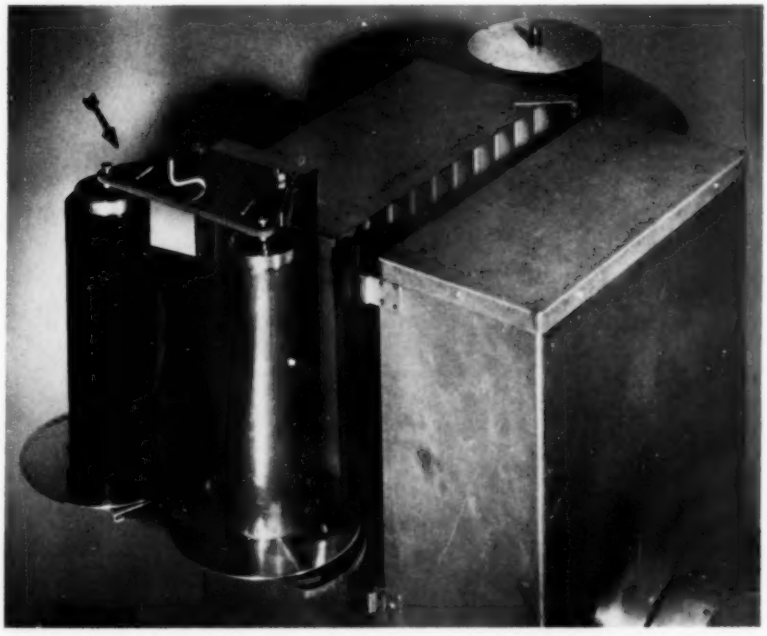

Fig. 2. Dryer, showing strip of film in transit, with dried film on "take-up" spool (arrow).

Smith, President of the Philadelphia Air Transport Company, who designed and manufactured the dryer.

525 East 68th Street,
New York 21, N. Y.

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SUMARIO

Nuevo Desecador para Películas en Rollo

Descríbese un nuevo desecador automático para películas en rollo que ha dado excelente resultado, ahorrando tiempo en la desecación y evitando la necesidad de prestar constante atención durante este período. Un motor de 115 voltios y 60 ciclos atiende al movimiento de la película y suministra corriente a abanicos gemelos; generan aire caliente tres unidades de calefacción situadas en el fondo del desecador y un cronómetro ya ajustado para el período calculado de desecación desconecta automáticamente el aparato.

El desecador, que se ha mostrado notablemente falto de defectos mecánicos, ya ha sido puesto a la venta.

EDITORIAL

Science in Radiology

Radiology, physics, and biology have never been separable in fact, yet it has often been difficult to arrange their proper wedding. Providing a common meeting ground is the first step toward bringing the scientists into that essential atmosphere wherein each can profit more from, and contribute most to the other. With this in mind, the Radiological Society of North America has for the past three years included a new feature in its annual scientific programs. Begun first as an experiment, the special sessions on radiological physics, radiobiology, and radiochemistry now appear to have become a firmly established part of these programs. The new sessions should perhaps be better described as an enlargement or an extension of a policy that for many years has attracted to the Radiological Society of North America scientists from the many fields contributing to clinical radiology. For at least twenty-five years the Society has devoted a day's sessions to such reports; however, the enormous and rapid growth of the contributing sciences over the past few years has necessitated the scheduling of more program time, even to the extent of running parallel sessions.

The popularity of the enlarged program is evidenced by the attendance at the sessions of more than 300 people each day. Moreover a substantial number of the listeners must be radiologists, for surely not more than half that number can be physicists, chemists, or biologists. This fact lends weight to the belief that the program is of clinical value and interest. Of particular note is the fact that this sympathetic outlet for reports from the contributing sciences is proving to be a strong attraction to the scientists.

Selection and arrangement of this new part of the program has not been easy. Meeting time allows the presentation of only a limited number of papers—some 24 at the 1954 meeting—divided into four sessions. Nearly twice that number were offered, and the task of choosing among them was difficult indeed. The first criterion is that the paper be reasonably close to the interests of the clinical radiologist. Papers of a more general and less clinical nature are properly presented before the Radiation Research Society. Another basis of selection is the relationship of the paper to the themes chosen for the year, *i.e.*, protection, telecurie technics, dosage standards, tracer studies, etc.

In an attempt to include as many papers as possible, the time of each presentation this past year was cut to fifteen minutes, with only five minutes allowed for discussion. Six papers to be given in two hours necessitated strict adherence to schedule. This all proved to be a mistake, and some of the sparkle of previous years was lacking.

In 1955 it is anticipated that the program can accommodate four sessions of five fifteen-minute papers each.[1] Informal discussions are planned rather than the more limited formal discussion, which seems to cramp the participants' style.

The Physics Committee of the Radiological Society of North America, in conjunction with the Program Committee, was successful in yet another experiment at the Los Angeles meetings. A last-minute evening program was arranged for

[1] Abstracts of papers offered for this program (Section B) must be submitted prior to June 15, 1955. Persons wishing to be placed on a mailing list for future notices regarding the Section B program should notify Dr. Lauriston S. Taylor, National Bureau of Standards, Washington, D.C.

the presentation of reports on radiological physics studies completed not more than four months prior to the meetings. This allowed disclosure of the most current advances in the field, something that has been lacking under ordinary program conditions with the submission deadline early in the year. Abstracts received up to three weeks before the meeting were considered, the choice being limited mainly by program space and the timeliness of the offering. The final program became available at the start of the meetings and included nine ten-minute presentations with discussion limited only by the Chairman. The abstracts were then published in the January issue of RADIOLOGY under the heading "Work in Progress."

The success of this feature was shown by the fact that, in spite of conflict with a social program, the meeting room was jammed. Papers were presented in an unusual atmosphere of informality and congeniality, and free rein was allowed for the discussions. It was interesting to note that the program drew to an end within two minutes of the estimated time without any alarm clocks or whipcracking by the Chairman. In 1955 this program will be held on Wednesday afternoon in parallel with the more purely radiological sessions.[2] Efforts will be made to insure that the two overlapping sessions involve a minimum of conflicting interests.

By such means as outlined above, it is hoped and believed that the Radiological Society of North America can continue to provide the common home and meeting ground for clinical radiology and the contributing sciences that have been so essential to its success.

LAURISTON S. TAYLOR, PH.D.

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[2] Papers for this program (Section C) should be submitted directly to the Chairman of the Physics Committee, Dr. H. O. Wyckoff, National Bureau of Standards, Washington, D. C., before Nov. 15, 1955. Papers submitted earlier for the regular program will not be acceptable for the Physics Committee program.

ANNOUNCEMENTS AND BOOK REVIEWS

KENTUCKY RADIOLOGICAL SOCIETY

At the January meeting of the Kentucky Radiological Society, the following officers were elected: President, Dr. H. L. Townsend, Louisville; Vice-President, Dr. A. L. Allen, Ashland; Secretary-Treasurer, Dr. David Shapiro, Jewish Hospital, 217 East Chestnut St., Louisville.

OHIO STATE RADIOLOGICAL SOCIETY

The Annual Meeting of the Ohio State Radiological Society will be held in the Mayflower Hotel, Akron, May 20–22.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY: MID-SUMMER CONFERENCE

The Seventeeth Mid-Summer Conference of the Rocky Mountain Radiological Society will be held in Denver, Colo., at the Shirley-Savoy Hotel, Aug. 18–20, 1955. Those planning to attend should obtain hotel reservations as early as possible.

JOSEPH FREEDMAN LECTURES UNIVERSITY OF CINCINNATI

On Saturday and Sunday, May 7 and 8, 1955, Dr. Felix G. Fleischner, Associate Clinical Professor of Radiology, Harvard Medical School, and Director of the Department of Radiology, Beth Israel Hospital, Boston, will deliver the seventh annual Joseph Freedman Lectures in Diagnostic Roentgenology at the University of Cincinnati College of Medicine. Radiologists desiring to attend are requested to write Dr. Benjamin Felson, Department of Radiology, Cincinnati General Hospital, Cincinnati 29, for further details.

EXTENSION COURSES UNIVERSITY OF SOUTHERN CALIFORNIA

The following notice, received too late for inclusion in the February issue of RADIOLOGY, is published here for the benefit of those who may be interested in the Second Section of the course announced.

A course especially designed for physicians in the field of radiology and those preparing for certification in this specialty will be offered by the University of Southern California, Division of Medical Extension Education, March 7 through May 23, 1955. The course, which also will provide background material for persons intending to secure clinical training for Atomic Energy Commission certification, will be divided into two sections. The First Section, "The Essential Physics of Therapeutic Radiology," will run from March 7 through April 11. The Second Section, "The Clinical Application of Radioactive Isotopes," will be presented April 18–May 23 at the Cedars of Lebanon Hospital. Sessions will be held on Monday of each week, 8:00 to 10:00 P.M.

Robert E. Pugh, Jr., physicist in radiology, and Dr. Henry L. Jaffe, Assistant Professor of Radiology at the University of Southern California, will serve as lecturers for the course. Dr. George Jacobson, Professor of Radiology and Head Radiologist, Los Angeles County Hospital, is acting as co-ordinator for the lectures.

Tuition for both sections is $75. Registration for only one section is $50. Further information may be obtained by writing to Dr. Robert S. Cleland, Medical Extension Education, University of Southern California, School of Medicine, 2025 Zonal Ave., Los Angeles 33, Calif.

CONFERENCE ON ELECTRICAL TECHNIQUES

The Eighth Annual Technical Conference on Electrical Techniques in Medicine and Biology will be held in November 1955, with Washington, D. C., tentatively scheduled as the meeting place.

The Conference, which is jointly sponsored by the American Institute of Electrical Engineers, the Institute of Radio Engineers, and the Instrument Society of America, serves as a meeting place for physiologists, biologists, cardiologists, radiologists, physicians, physicists, electronic, electrical, and instrument engineers. A large portion of the registration is drawn from the research groups in universities and industry.

Authors are invited to submit titles of papers for consideration by the Program Committee to E. Dale Trout, Conference Chairman, 4855 Electric Avenue, Milwaukee 1, Wis.

HANDBOOK 57 NATIONAL BUREAU OF STANDARDS

Announcement has been made by the National Bureau of Standards of the publication of its *Handbook 57: Photographic Dosimetry of X- and Gamma Rays*, by Margaret Ehrlich. This *Handbook* contains primary factual data and basic principles necessary for photographic dosimetry of x- and gamma rays, representing the results of an extensive program in this field conducted over a number of years by the Radiation Physics Laboratory of the National Bureau of Standards.

The *Handbook* may be obtained from the Government Printing Office, Washington, D. C. Price 15 cents. Foreign remittances should be in United States exchange and should include an additional one-third of the publication price to cover mailing costs.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

RADIOISOTOPE CONFERENCE, 1954. Volume I: Medical and Physiological Applications. Volume II: Physical Sciences and Industrial Applications. Proceedings of the Second Conference, Oxford, July 19–23, sponsored by the Atomic Energy Research Establishment, Harwell. Edited by J. E. JOHNSTON, assisted by R. A. FAIRES and R. J. MILLETT. Volume I: 418 pages with numerous illustrations, including graphs, autoradiographs, and photographs. Volume II: 224 pages, with illustrations. Published by Academic Press Inc., N. Y., and Butterworths Scientific Publications, London, 1954. Price: Vol. I, $10.80; Vol. II, $7.50; Vols. I and II, $16.00.

TUMOURS OF LYMPHOID TISSUE. By GEORGE LUMB, M.D., Reader in Pathology, Westminster Medical School, London University; Consultant Pathologist, Westminster Hospital; Lecturer in Pathology, Institute of Basic Medical Sciences, Royal College of Surgeons of England. With a foreword by Sir Stanford Cade, K.B.E., C.B., D.Sc., F.R.C.S., M.R.C.P., F.F.R.; Senior Surgeon, Westminster Hospital. A book of 204 pages, with numerous illustrations including black and white as well as colored photomicrographs. Published by E. & S. Livingstone, Ltd., Edinburgh & London; Williams & Wilkins Co., Baltimore, Md., 1954. Price $8.00.

SEVENTEENTH SEMIANNUAL REPORT OF THE ATOMIC ENERGY COMMISSION, January 1955. A booklet of 138 pages. Also a Cumulative Index to the First Fifteen Semiannual Reports to Congress, January 1947–December 1953. Published by the Government Printing Office, Washington, D. C. Price of Index 35 cents.

LA PHLÉBOGRAPHIE PELVIENNE PAR VOIES VEINEUSE, OSSEUSE ET UTÉRINE. APPLICATION A L'ÉTUDE DES PHLÉBITES ET DES CANCERS. By P. GUILHEM, Professeur de Clinique Obstétricale à la Faculté de Médecine de Toulouse and R. BAUX, Assistant des Hôpitaux de Toulouse. A monograph of 134 pages, with 75 illustrations. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris, (VI°) 1954. Price 1,500 fr.

Book Reviews

HANDBOOK OF RADIOLOGY. Edited by RUSSELL H. MORGAN, M.D., Professor of Radiology, School of Medicine, The Johns Hopkins University, Radiologist-in-Chief, The Johns Hopkins Hospital, and KENNETH E. CORRIGAN, PH.D., Associate Professor of Radiobiology, Wayne University, Director, Radiological Research Department, Harper Hospital, Detroit, Mich. A volume of 518 pages, with numerous illustrations, tables, and graphs. Published by the Year Book Publishers, Inc., 200 East Illinois St., Chicago, 1955. Price $10.00.

Drs. Morgan and Corrigan, in their *Handbook of Radiology*, have supplied the need, long felt by workers in the field of radiation, for a single source of information for the quantitative data that have been scattered throughout radiological journals and books. The scheme of arrangement is similar to that of the well known *Handbook of Physics and Chemistry* which has been used by two generations of scientists. A large part of the work consists of tables giving data on such subjects as absorption coefficients, units and conversion factors, depth doses for radiation ranging from Philips contact therapy to telecobalt therapy, and dosage from radium sources, as well as mathematical tables of logarithms and exponential and trigonometric functions. Graphs and drawings are used when this method is preferable, as, for example, to illustrate positioning in radiography and for isodose lines around radium sources. Isotope decay schemes and dosage formulae are given, and there is a section on protection. Physical terms and units are defined.

Great care has been used by the authors in selecting the most reliable data available in every instance the authority being cited where practical, and the book may be used with confidence. The time saved by having such a book at hand for ready reference is incalculable.

ANNUAL REVIEW OF NUCLEAR SCIENCE, Volume 4, 1954. Edited by J. G. BECKERLEY, U. S. Atomic Energy Commission; MARTIN D. KAMEN, Washington University Medical School; LEONARD I. SCHIFF, Stanford University. A volume of 430 pages, with 82 illustrations. Published by Annual Reviews, Inc., in co-operation with the National Research Council of the National Academy of Sciences, 1954. On sale by Annual Reviews, Inc., Stanford, Calif. Price $7.00.

This fourth volume of the *Annual Review of Nuclear Science* contains seventeen chapters, three of which are devoted to methods of nuclear particle detection (fast electronics, scintillation and Čerenkov counters). Other chapters which might be of interest to the radiologist deal with recent developments in proton synchrotrons, standardization of radioactive sources, biochemical effects of radiation, and vertebrate radiobiology. The material is well presented, concise and yet complete. The illustrations are excellent and detailed bibliographies, some of which run to several hundred references, accompany the chapters. To those who wish to keep up with general developments in the field of nuclear science these annual reviews are invaluable.

HISTOLOGY. Edited by ROY O. GREEP, PH.D., Dean and Professor of Dental Science, Harvard School of Dental Medicine, with thirteen contributors. A volume of 953 pages, with 648 illustrations. Published by the Blakiston Co., Inc., New York, 1954. Price $15.00.

Extensive multiple authorship of an American textbook of histology has materially strengthened the impact of such a work. The difficulties of correlating fine structure with light, phase and electron microscopy, as well as histochemistry, have thus been met by diversified responsibility in individual fields of interest. The volume has gone far to accomplish such needed correlation both in the written word and illustration. Although in reality this is a new text, some of the illustrations are drawn from Bremer and Weatherford's *A Textbook of Histology*. In fact, the work was originally conceived as a sixth edition of the Bremer and Weatherford text, although it did not eventuate as such. The descriptions of definitive microscopic anatomy at the three levels mentioned above are straightforward and complete, but the most rewarding features are the new interweavings of chemical and physiologic cytology with the unceasingly expanding knowledge of structure.

RÖNTGENDIAGNOSTIK DES SCHÄDELS. By PROF. DR. WILLY LOEPP, weil. a. o. Prof. für Röntgenologie an der Universität Königsberg (Pr.), and PROF. DR. REINHOLD LORENZ, Apl. Prof. an der Universität Hamburg; Chefarzt des Röntgeninstituts des Krankenhauses, Hamburg-Barmbek. A volume of 580 pages, with 696 illustrations. Published by Georg Thieme, Stuttgart, 1954. Distributed in the United States and Canada by the Intercontinental Medical Book Corp., 381 Fourth Ave., New York. Price DM 97.—

This encyclopedic work is based on simple radiography without the aid of contrast media. That a wealth of information is obtainable by diligent study of the skull without the use of specialized contrast technics is amply demonstrated.

The material is divided into sections dealing with the normal skull, growth disturbances, hereditary diseases, endocrine disturbances, disturbances associated with internal diseases, disturbances as part of generalized bone diseases, storage diseases, avitaminoses, parasitic and inflammatory diseases, benign and malignant tumors, fractures, pathology of the base of the skull, sella turcica, temporal bone, paranasal sinuses and orbit, roentgenologic evidences of increased intracranial pressure, endocranial calcifications, teeth and jaws, concluding with a chapter on technic.

The table of contents covers eleven pages. In spite of the wide variety of subjects presented, including such items as tumors of the facial nerve and jugular glomus, the discussions are complete and to the point. Though the illustrations are positives, rather than the negative form more familiar to the American reader, they are in general satisfactory.

Since an adequate technical examination including multiple projections is invaluable in the complete examination of the skull, especially the temporal bone, considerable space is devoted to technic. While the roentgenograms obtained by the several technics are furnished, along with excellent line drawings, actual illustrations of the procedures themselves might have been helpful.

The bibliography covers sixteen pages and is predominantly German. The format is excellent, as is to be expected from this publishing house.

KLINISCHE FEHLDIAGNOSEN. By PROF. DR. M. BÜRGER, Direktor der med. Universitätsklinik, Leipzig. Second edition. A volume of 550 pages, with 214 illustrations and 55 tables. Published by Georg Thieme, Stuttgart, 1954. Distributed in the United States and Canada by the Intercontinental Medical Book Corp., 381 Fourth Ave., N. Y., 1954. Price DM 59.40—($14.15)

Klinische Fehldiagnosen, meaning literally "Clinically Missed Diagnoses," is a unique textbook on differential diagnostic problems. Two hundred and nine cases are presented in which the original diagnoses were incorrect as subsequently proved by biopsy, autopsy, or laboratory methods. On the basis of these, the author discusses in a systematic and instructive way the differential diagnostic aspects of various diseases. At the same time he points out why the diagnoses, which could have been made correctly, were missed, and uses the opportunity thus afforded to bring out the indications and limitations of various commonly used laboratory methods.

The book is divided into two parts. The first section, or "General Part," covers 94 pages. Seventeen well chosen examples of missed diagnoses are used to show commonly committed errors in taking the patient's history, in doing the physical examination, and in interpreting laboratory results. Great stress is placed on the limitations of various laboratory procedures. A short passage is devoted to the clinical significance of negative radiologic findings.

In the second or "Special Part," comprising some 440 pages, the author covers errors in diagnosis of diseases of the various anatomical systems, following this by a chapter devoted to occupational and infectious diseases. One hundred and ninety-two cases with originally missed diagnoses taken from hospital files are used. Various laboratory methods in this connection are reviewed and their value and their limitations in particular diseases are stressed. A few cases are presented as examples of common radiological misdiagnoses, such as antral cancer interpreted as antral gastritis, sigmoid diverticulitis read as neoplasm, and others of a similar nature.

The text is clear and precise. The cases are well chosen and cover a great variety of clinical entities

in all age groups. The illustrations are excellent. Most commonly used diagnostic methods are discussed at some length, though radiology is given a rather insignificant place. The book is highly instructive, particularly to those who are engaged in clinical fields at the beginning of a medical career.

MALADIES DES OS ET DES ARTICULATIONS. By STANISLAS DE SÈZE, Professeur agrégé á la Faculté de Médecine de Paris, Medecin de l'Hôpital Lariboisière, and ANTOINE RYCKEWAERT, Médecin-Assistant des Hôpitaux de Paris. A loose-leaf volume of 1,240 pages, with 391 figures. Published by Editions Médicales Flammarion, 22 rue de Vaugirard, Paris, 1954.

This large monograph contains fourteen chapters under the general heading "Osseous Pathology," seven chapters on "Articular Pathology," and five chapters on "Juxta-Articular Pathology." The general approach is by discussion of separate diseases as they affect the bones and joints as opposed to the topographic approach that is sometimes used in monographs on the skeletal structures. Historic, pathologic, pathogenetic, chemical, and clinical data are included in the discussion of various disease processes. The historical data and the abundant bibliography attest to the importance of contributions of earlier French writers in this field.

Some of the more recently described disease processes, such as aneurysmal bone cyst and hypophosphatasia, are omitted. Otherwise, the monograph is a rather complete treatise and worthy of perusal by those who read French.

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

The Angle of the Base of the Skull in the X-Ray Picture. W. Bergerhoff and R. Stilz. Fortschr. a. d. Geb. d. Röntgenstrahlen **80:** 618–622, May 1954. (In German)

The authors report on 772 x-ray examinations of skulls in the lateral projection. The patients, seen in the Köln University Neurosurgical Clinic, comprised a heterogeneous group, including both sexes and ranging in age from three years to senility.

Reference is made to measurements by various authorities for determining the angle of the base of skull. Welcker's determinations were based on the "sphenoidal angle," formed by an anterior line extending from the nasion to the tuberculum sellae and a posterior line from this point to the basion (anterior margin of the foramen magnum). Others have used somewhat different planes (Landzert and Pankow). The angle is regarded as a "constant" for the architecture of the skull and remains practically unchanged from early childhood to maturity. For males, it was found to be between 132.62 and 134.25°. For females, it ranged from 131.46 to 133.26°. The average for males was accepted as 133.44°, and for females 132.36°. The angle is useful in determining normal skull architecture and its variations.

Three drawings; 1 table. E. W. Spackman, M.D.
Fort Worth, Texas

Intracerebral Arteriovenous Malformations: Their Diagnosis and Angiographic Demonstration. Wendell G. Scott, Wayne A. Simril, and William B. Seaman. Am. J. Roentgenol. **71:** 762–775, May 1954.

Intracerebral arteriovenous malformations are a more frequent cause of intracranial disorder than was formerly believed, and their recognition has assumed greater importance as advances in neurosurgery make many of them amenable to extirpation. The present paper is based on a series of 22 cases, of which 17 were arterial angiomas with arteriovenous connections and 5 were carotid-cavernous fistulas.

Of the angiomatous arteriovenous malformations, a relatively large proportion occurred in children. The most common symptom was headache. Episodes of unconsciousness and periods of coma occurred in 11 cases, and epileptiform seizures in 6.

The symptoms of carotid-cavernous fistulas, like those of the angiomatous malformations, are dependent upon the number and size of the vessels and the area of the brain involved and, in addition, upon the diameter of the arteriovenous communication. A bruit, pain behind the eye, diplopia, photophobia, and a pulsating exophthalmos were present in all of the present series.

The authors stress the importance of cerebral angiography for comprehensive understanding of the location, size, extent, arrangement, and vascular connections of intracerebral arteriovenous malformations. They have used the biplane angiographic unit with roll film cassettes (see Radiology **56:** 15, 1951), though satisfactory results can be obtained with conventional roentgenographic equipment.

Surgical extirpation is the treatment of choice whenever feasible, the criteria for surgical intervention being based on the angiographic visualization of the malformation, its location within the brain, and careful evaluation of the neurological damage that may result from the surgical effort.

Eighteen roentgenograms; 2 photographs; 3 tables.
Thomas E. Padgett, M.D.
University of Louisville

Familial Incidence of Congenital Aneurysms of Cerebral Arteries. Report of Cases of Ruptured Aneurysms in Father and Son. William R. Chambers, Byron F. Harper, Jr., and James R. Simpson. J.A.M.A. **155:** 358–359, May 22, 1954.

The congenital nature of intracranial aneurysms is generally accepted but reports of their familial occurrence are uncommon. The author believes the cases presented here to be the first examples to be described in father and son.

In the father, the diagnosis was made by angiography, which revealed the aneurysm in the course of the left middle cerebral artery. Angiography was also done in the son but failed to demonstrate the lesion, which was subsequently found at autopsy. This latter case serves as a tragic illustration of the fact that failure to demonstrate an aneurysm by arteriography does not rule out its presence.

Two roentgenograms. Paul Massik, M.D.
Quincy, Mass.

Tuberculomas of the Brain and Cerebellum. P. Descuns, H. Garré, and C. Phéline. J. Neurosurg. **11:** 243–250, May 1954.

Whereas surgical treatment of tuberculomas of the brain was formerly followed in the majority of cases by a tuberculous meningitis with fatal result, today the judicious operative and postoperative use of Streptomycin makes it possible to attack these tumors and remove them, piecemeal if necessary, with a much better outlook.

This paper concerns the experiences of the authors with the surgical treatment of intracranial tuberculomas in 38 patients in North Africa. Of this number, all but 3 were natives of the area. Lesions were usually advanced; 50 per cent of the patients were blind at the time of operation. Contrary to the experience of others, more than half of the tuberculomas were found in the cerebral hemispheres. The remainder were in the posterior fossa. Ventriculography was used but is not free from the danger of cerebral edema and squeezing of the brain stem. Angiography is the preferred means of localization of the tumor in the hemispheres.

With thorough removal and the use of Streptomycin locally during surgery and postoperatively, the authors have attained a definite reduction in the mortality rate in comparison with cases treated before the discovery of the drug. Even where operation has been only palliative, because of inaccessibility of the whole growth, results have been improved.

Four roentgenograms; 3 photographs; 1 table.
John F. Riesser, M.D.
Springfield, Ohio

Cleidocranial Dysostosis with Osteopetrosis. L. Giaccai, Maria Salaam, and H. Zellweger. Acta radiol. **41:** 417–424, May 1954.

The authors report the case of a 20-year-old Arab with cleidocranial dysostosis, osteopetrosis, and mental deficiency. The patient had a peculiar facies, was of

short, slender stature with a brachycephalic head and bowed legs; he was antagonistic and mentally confused. Roentgenologic examination showed all the cranial sutures to be widened; the paranasal sinuses were poorly developed, and the base of the skull and maxillary bones were dense. The facial area was disproportionately small in comparison with the cranium and many of the deciduous teeth were still present. There was a gap of about 2 cm. between the lateral end of the clavicle and acromion on each side; the ribs were of uniformly increased density, and the posterior ends of the 10th and 11th left ribs showed the presence of fractures with advanced callus formation. The vertebral bodies of the dorsal and lumbar spines had deep notches on the ventral aspects, with a permanent wide vascular canal and epiphyseal plates which were moderately and uniformly condensed. The bodies were spool-shaped.

The defective ossification of the cranial plates, the dental abnormalities, and developmental defects of the clavicles, along with dysplasia of the phalangeal bones and hypoplasia of the maxilla and mandible were typical of cleidocranial dysostosis. Characteristic of osteopetrosis were systemic bone sclerosis, brittle bones with marked transverse fractures, spool-shaped vertebral bodies with condensed epiphyseal plates and persistence of wide vascular channels, aplasia of the paranasal sinuses and the mastoids. In addition, there was severe mental deficiency with psychotic features.

In their discussion, the authors cite several reported cases of the coexistence of cleidocranial dysostosis and osteopetrosis, with one or the other predominating. It would appear that a connection exists between the two, or at least that there is an osteosclerotic type of cleidocranial dysostosis which so far has not been described. In the authors' case the brother of the patient showed evidence of osteosclerosis without signs of cleidocranial dysostosis.

Although the etiology of these conditions is unknown, there is good evidence pointing toward an early developmental aberration of the mesenchyma, beginning in the first weeks of embryonal life. The hypothesis seems justified that cleidocranial dysostosis and osteosclerosis may be due to a common etiologic factor responsible for a two-directional derangement in the developmental process of the mesenchyma.

Seven roentgenograms; 1 photograph.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Metastatic Malignancy of the Jaws. S. Gordon Castigliano and C. Jules Rominger. Am. J. Surg. **87**: 496–507, April 1954.

Metastatic cancer involving the jaws is rare. Seven new cases are here added to the 176 reported between 1902 and 1953. Six of the 7 involved the mandible.

The authors make a sharp distinction between metastasis and invasion of the mandible by oral cancer, which is relatively frequent. In some cases jaw metastasis may be the first and only symptom of malignant disease growing silently elsewhere in the body. Usually, if the mandible is involved, there is detectable metastatic disease elsewhere.

The primary lesions most frequently accounting for jaw metastasis are carcinoma of the thyroid, hypernephroma, carcinoma of the breast, carcinoma of the lung, and carcinoma of the prostate. Metastatic lesions have also been reported from carcinoma originating in the following organs: stomach, large intestine, rectum, parotid gland, tonsil, adrenal gland, ovary, testis, lip, and nasal mucosa; from sarcoma of the ovary, breast, and bone; from lymphosarcoma, Kaposi's sarcoma, and malignant melanoma.

Symptoms include paresthesia, numbness and swelling of the lip, pain and tenderness, "toothache," an external mass, and loosening of the teeth.

A full and accurate history and complete physical examination are essential to correct diagnosis. Roentgenographically, metastatic cancer of the jaw may be confused with primary cancer of the oral cavity or mandible, benign tumors, cysts, and infections of dental origin. In the presence of suggestive symptoms in a patient with known cancer elsewhere, dental films and lateral views of the jaw should be obtained to rule out involvement before removal of the teeth. In some instances, however, even with advanced disease, no roentgen changes may be demonstrable.

Five roentgenograms; 4 photographs; 1 photomicrograph; 2 tables.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Roentgen Recognition of Parathyroid Adenoma. Stanley M. Wyman and Laurence L. Robbins. Am. J. Roentgenol. **71**: 777–783, May 1954.

The authors report a series of 34 surgically proved parathyroid adenomas, with roentgen localization of the tumor in 20 cases. They stress the importance of such localization as a guide to the surgical approach.

Three conditions must be met in order to recognize the existence of a soft-tissue mass in the neck: (1) The mass must have attained a certain minimum size. (2) It must be so located that it impinges upon or displaces certain structures easily recognized on the roentgenogram, such as the trachea, esophagus, and lungs. (3) The examination must be as complete as possible, including roentgenoscopy, spot filming with barium in the esophagus, and large conventional roentgenograms of good technical quality of the chest and lower neck.

The most significant roentgen finding is actual demonstration of the outline of a soft-tissue mass. This, however, is unusual. In the majority of cases, only secondary evidence is available, in the form of indentation of the esophagus, trachea, or both. Hyperplasia, cystic changes, and carcinoma of the parathyroid glands may produce a roentgen appearance which is identical with that of one or more adenomas. Also to be considered in the differential diagnosis are such varying and bizarre conditions as branchial cleft cysts, cystic hygroma, connective-tissue tumors, diverticulum of the esophagus, and intramural extramucosal tumors. Indentations of the cervical esophagus by the cricopharyngeus muscle, whether normal or hypertrophied, may be a confusing problem, as also may an enlarged thyroid.

Nine roentgenograms; 1 table, including details of the 20 cases localized roentgenographically.

CLAUDE D. BAKER, M.D.
University of Louisville

THE CHEST

Pulmonary Collapse and Consolidation. The Role of Collapse in the Production of Lung Field Shadows and the Significance of Segments in Inflammatory Lung Disease. A. C. Dornhorst and J. W. Pierce. J. Fac. Radiologists **5**: 276–281, April 1954.

The authors make two points: (1) that collapse of

the lung is seldom the sole explanation of increased density seen in the lung field, (2) that strict limitation of consolidation to bronchopulmonary segments is not a feature of simple pneumonia but suggests bronchial disease.

(1) It is stated that, as a lung shrinks under a pneumothorax, its density does not increase appreciably until its projected area is reduced to about one-tenth, after which a rapid increase in density occurs until total airlessness is reached. This is explained on the basis that, over a wide range, alterations in the compactness of the lung are about balanced by contrary changes in blood content, the net radiological density being unchanged.

The frequent combination of some shrinkage with heavy opacity must entail the replacement of air by exudate. This circumstance is particularly common in bronchial carcinoma; the consolidation is often inflammatory but may be serous, and is probably associated with lymphatic obstruction. When the consolidation has cleared, study of the landmarks will often show that no volume change has occurred. To report "re-expansion" in such cases is in error and may be misleading. Although shadows due solely to complete collapse of a lobe do occur, shadows due to simple collapse of individual pulmonary segments are very uncommon.

(2) When a bronchus is diseased, the lung segment supplied by it differs in its circumstances from the rest, and it is not surprising that inflammation should often occupy the whole segment and yet be sharply delineated at its boundaries. The significance of such segmental lesions lies in the possibility of inferring that th tissues in the segment share a common susceptibility, and of suspecting that the common bronchial supply is to blame.

The authors believe this inference is valid because, in their experience, inflammation occurring in a previously undamaged lung is not usually so localized. Pneumococcal pneumonia, for example, commonly produces sublobar opacities and the most frequent patterns will not fit into a segmental description. Accordingly, when an area of consolidation occupying less than a lobe is sharply defined all around, one should suspect a region of low resistance to infection, either because of pre-existing scarring or because the common bronchus is diseased.

Nine roentgenograms; 2 photographs; 2 diagrams.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Spontaneous Pneumothorax and Its Treatment. Lorence T. Kircher, Jr., and Robert L. Swartzel. J.A.M.A. **155**: 24–29, May 1, 1954.

Thirty-five cases of spontaneous pneumothorax seen in an Air Force Base Hospital are analyzed by the authors with respect to the indications for conservative or surgical treatment. In 16 cases treated by bed rest alone they found that the air was absorbed at a fairly constant rate of 1.25 per cent per day.

Although the amount of collapse cannot be measured directly, it was found possible to estimate this on a chest roentgenogram. The method employed involved the drawing of two rectangles on the film, an outer rectangle representing the area of the involved hemithorax, and an inner representing the area of collapse. For the outer rectangle, the inferior border of the first rib, was used as the upper line and the costophrenic angle as the lower outer corner. The apex of the collapsed lung marked the upper border of the inner rectangle, and the lateral edge of the base of the collapsed lung its lower outer corner. For each, the center of the mediastinum formed the inner side. The percentage of collapse was then calculated on the basis of the areas of the two rectangles. This permitted determination of the subsequent rate of air absorption, which in turn made possible prediction of the time required for re-expansion.

Since the concern of the authors was the return of their patients to duty as soon as possible, they selected the figure of 20 per cent collapse as calling for surgical treatment. For such cases catheter drainage with water seal was tried as the initial procedure, but if re-expansion was not complete in thirty-six to forty-eight hours, continuous suction was applied. If significant bleeding accompanies collapse, two catheters may be used with suction, since the bleeding will stop sooner if the pleural surfaces are approximated.

Only 1 patient in the authors' series was treated by thoracotomy after recovery. This patient had had six episodes of collapse. Wedge resection of bullae at the lung apex was done, and talc was instilled to produce pleural space obliteration.

Several representative cases are reported in detail, and the technic of intercostal tube insertion and drainage is described.

Two roentgenograms.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Some Relations between Pulmonary Edema and Pulmonary Inflammation (Pneumonia). Eugene D. Robin and E. Donnall Thomas. Arch. Int. Med. **93**: 713–724, May 1954.

Pulmonary edema and pneumonia frequently coexist, the occurrence of one predisposing to the development of the other. A differential diagnosis on the basis of the history, physical signs, laboratory studies, or x-ray findings may be difficult or even impossible. In a study of autopsy and hospital records, it was found that if one of these entities were present there was approximately a 25 per cent chance that the other would be noted at postmortem examination. A patient may show many of the classic features of one syndrome during life, and at autopsy be found to have chiefly the other lesion.

Pneumonia usually starts as a localized pulmonary edema. In lung tissue adjacent to the area actually involved in the pneumonic process, there is an area of congestion and edema. The edema probably is the result of many factors, including pulmonary capillary damage associated with inflammation and local interference with oxygenation, producing anoxia. The systemic effects of pneumonia often result in myocardial abnormality. Not only may the rate of fluid entering the alveoli be increased by pneumonia, but the rate of fluid resorption by lymphatics may be decreased.

The general status of the patients in acute pulmonary edema is such as to provide excellent conditions for the development of pulmonary infection. Pulmonary edema fluid affords an excellent culture medium in which these organisms may multiply.

The authors state that prophylactic chemotherapy is indicated in the routine management of the patient with acute pulmonary edema and that the treatment of pneumonia should take into consideration the possibility of pulmonary edema.

Six roentgenograms; 1 schematic drawing.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

Intralobar Bronchopulmonary Sequestration. André J. Bruwer, O. Theron Clagett, and John R. McDonald. Am. J. Roentgenol. **71**: 751–761, May 1954.

Intralobar bronchopulmonary sequestration is a partial or complete developmental separation of a portion of a lobe of a lung from its continuity with the normal bronchial tree. It is distinct from extralobar sequestration, in which the anomalous pulmonary tissue is found either between the diaphragm and the lower lobe or below the diaphragm. In intralobar sequestration the tissue lies enclosed within the pleura of the involved lower lobe.

The authors found 79 cases in the literature and add 5 of their own. Clinically the condition usually becomes manifest before the age of thirty, with intermittent cough, occasional blood-streaked sputum, fever, and chills. On the roentgenograms, there is a round or oval area of homogeneous density situated medially at one of the bases. In the lateral view, the lesion can be located in the posterobasal segment. If, at the time of examination, there is a communication between the bronchial tree and the sequestrated area, one or more fluid levels will be seen. On bronchography, the involved region invariably fails to fill. These roentgen features should suggest the correct diagnosis and prevent treating the patient for a lung abscess or empyema.

In the authors' specimens the anomalous arteries usually entered the lung in the region of the lowermost portion of the pulmonary ligament. No veins were found, and drainage is presumed to take place *via* the regular pulmonary system.

The 5 cases are reported in detail with appropriate roentgenograms and a photograph of one of the specimens.

Twelve roentgenograms; 1 photograph; 1 drawing.

LAWRENCE A. DAVIS, M.D.
University of Louisville

A New Radiologic Sign in the Clinical Diagnosis of Hyaline Membrane in the Lung. Emilio Soto Pradera, Juan Silverio Latour, José R. Montalvo, and Dagoberto Rodriguez Molina. Rev. cubana de pediat. **26**: 327–332, May 1954. (In Spanish)

In 1925 Johnson and Meyer (Am. J. Obst. & Gynec. **9**: 151, 1925) reported for the first time the postmortem finding of a membrane obstructing the terminal bronchi and alveolar ducts in the lungs of the newborn prematurely dead of respiratory disease. This finding was attributed to the inhalation *in utero* of vernix caseosa and amniotic liquid. This mixture in contact with air became hardened, giving rise to a hyalinoid substance, which came to be known as a "hyaline membrane," or "vernix membrane."

The authors believe that they have discovered an original radiologic sign of this condition, which they communicated at the Seventh International Congress of Pediatrics, recently held in Havana. A similar finding has been reported by Meschan, Marvin, Gordon, and Regnier (Radiology **60**: 383, 1953). It consists in the roentgen demonstration of good aeration of the lungs paradoxically associated with clinical deterioration. This phenomenon is explained as follows: Several hours after birth, there is formed in the smaller pulmonary ducts (terminal bronchioles and alveolar ducts) the hyaline membrane. This membrane prevents the oxygen of the expired air from coming in contact with the pulmonary surface destined to absorb it—that is, the alveoli—and an anoxia results. In order to fight against this, the infant increases its respiratory minute-volume but nevertheless does not succeed in obtaining better oxygenization. There is thus produced a gaseous dilatation of the terminal bronchi and alveolar ducts which leads to alveolar atelectasis, giving rise to the appearance of better pulmonary aeration in spite of the worsening of the clinical condition. This is called by the authors the "sign of blocked hyperventilation," and will permit the diagnosis of hyaline membrane in the living.

JAMES T. CASE, M.D.
Santa Barbara, Calif.

Linear X-Ray Shadows in Acquired Pulmonary Hemosiderosis and Congestion. Felix G. Fleischner and Leopold Reiner. New England J. Med. **250**: 900–905, May 27, 1954.

Faint horizontal linear shadows, persistent or transient, are often observed in the lower lateral fields of the lung in patients with acute or chronic pulmonary congestion. These lines run perpendicular to the lateral chest wall and parallel to one another, being spaced 0.5 to 1.0 cm. apart. They may extend into the lung field 1.0 or 3.0 cm.

The *persistent* lines were found to be cast by hemosiderin, alongside or within interlobular septa. In patients with chronic congestion, there may be no other x-ray evidence of pulmonary hemosiderosis.

The *transient* horizontal linear shadows appear to be due to widening of the interlobular septa by edema fluid.

Four roentgenograms; 2 photographs; 1 photomicrograph.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

Bronchographic Studies in Bronchiectasis Before and After Pulmonary Resection. J. Antrim Crellin, J. Stauffer Lehman, Daniel Mason, and Joseph L. Curry. Am. Rev. Tuberc. **69**: 657–672, May 1954.

A preoperative and postoperative bronchographic study was obtained in 44 non-consecutive cases of bronchiectasis to demonstrate the rearrangement of the bronchial tree and the presence of residual or new areas of bronchiectasis following surgical resection. The extent and degree of bronchial rearrangement and displacement of the remaining bronchi was found to be in proportion to the volume of lung removed in every case. In 25 patients there was no evidence of residual or new bronchiectasis in the operated lung; in 4 there was persistence of a bronchiectatic segment thought to have been removed. In 4 patients, postoperative bronchiectasis developed as the result of complications (empyema with bronchopleural fistula). In 10 cases there was no definite complication to explain the development of bronchiectasis in segments which had been considered normal on the basis of preoperative bronchograms. Clinical results following surgical resection of the diseased segments were good to excellent in 39 cases, fair in 1, and poor in 4 cases.

Several factors may play a part in the development of bronchiectasis following surgical resection. It is possible that minor changes (dilatations) in bronchi are overlooked preoperatively and that these develop into recognizable bronchiectasis. There is always some distortion of bronchi in the rearrangement which follows resection, and it is likely that there is interference with bronchial drainage resulting in an increased pos-

sibility of bronchopulmonary suppuration and bronchiectasis. Other factors also probably play a part, but it is unlikely that bronchiectasis in a contralateral lung acts as a source of infection, since the disease is often unilateral.

Twenty roentgenograms, with accompanying drawings.

JOHN H. JUHL, M.D.
Minneapolis, Minn.

The Early Detection of Lung Cancer by Means of Photofluorography. R. Honold. Schweiz. med. Wchnschr. **84**: 431–439, April 17, 1954. (In German)

A review of the literature covering approximately 4,500,000 chest photofluorograms revealed that approximately 1 in 800 exhibited changes suspicious of bronchogenic carcinoma. The incidence of *verified* bronchogenic carcinoma varied from 1 in 12,000 to 1 in 15,000.

The author's own material consists of 354,149 photofluorograms of the chest—24 × 24 mm.—obtained in the canton of Zürich between 1946 and 1951. The survey included the whole population of the district, 35 per cent of which was made up of children under fifteen years of age, differing in this respect from other studies such as industrial plant surveys or examinations of hospital personnel and patients. There were many unavoidable duplications in the survey, so that the number of examined persons is considerably smaller than that of the photofluorograms.

In 12 persons bronchogenic carcinoma was detected photofluorographically. This is estimated by the author to represent an incidence of 1 in 19,000. All of the group were males, 2 of whom were under fifty years of age. Nine were free of complaints. The interval between photofluorographic detection and a more complete study ranged from fourteen days to twenty-five months, with an average of five and a half months. Consequently, when therapy was instituted, only one patient was considered operable. He died shortly after operation of cardiovascular failure. Six had either died in the interval or refused treatment when an attempt was made to hospitalize them. Five received radiotherapy. The average life span after photofluorography was short. Only 5 survived as long as six months and only 1 three years.

In order to determine how often carcinoma was overlooked, the previous photofluorographic records of all cases of bronchogenic carcinoma listed in the files of the canton hospital were consulted. In this review, 19 patients were found who had passed this procedure without being classed as suspicious or abnormal. Re-evaluation of the films revealed that 6 were positive. In 2 instances the x-ray changes were obvious and complaints were present at the time of the study. In the other 4 the changes were less striking on the films and symptoms were absent for another eight to sixteen months, despite the positive radiographic findings. The principal error lay in the failure to recognize hilar enlargement.

The time interval between the taking of the truly negative photofluorograms and the recognition of bronchogenic carcinoma in the remaining 13 cases is not stated. [Since chest photofluorograms were taken every three years on all inhabitants of the cantonal district in which this study was made, it is reasonable to assume that it was less than thirty months.—G. S. S.]

The author recommends the taking of miniature photofluorograms every two years in the unselected population and every year on all males over forty-five years of age. He further believes that the 24 × 24-mm. films should be abandoned in favor of those measuring 36 × 36 or 70 × 70 mm., and that work-up of suspicious cases should be undertaken within fourteen days after discovery.

Twenty-one roentgenograms.

GERHART S. SCHWARZ, M.D.
New York, N. Y.

Determination of the Operability of Bronchial Cancer by Angiopneumography. G. Melot, A. Bollaert, F. Declercq, A. De Coster, A. Dumont, and A. Duprez. J. belge radiol. **37**: 369–394, 1954. (In French)

Seventy-one patients with carcinoma of the lung were studied by means of angiopneumography in an attempt to establish criteria for resectability. Important manifestations for consideration are invasion or compression of main arteries near the hilus and invasion or compression of the superior vena cava and brachiocephalic veins with establishment of collateral circulation. These changes may be caused by the primary tumor or metastases, or by both.

When invasion of blood vessels is demonstrated near the hilus, or when evidence of contralateral metastasis is seen, the prognosis is poor. On the other hand, when the vascular alterations are limited to segmental or lobar arteries, the possibility of curative resection is greater.

Eleven roentgenograms; 15 drawings.

CHARLES M. NICE, JR., M.D.
University of Minnesota

Bronchographic Abnormalities in Alveolar Cell Carcinoma of the Lung. A New Diagnostic Sign. Norman Zheutlin, Elliott C. Lasser, and Leo G. Rigler. Dis. of Chest **25**: 542–549, May 1954.

The authors describe a new roentgen sign that is highly suggestive for a diagnosis of alveolar-cell carcinoma. Bronchography in these cases reveals a characteristic pattern. The segmental bronchi in the involved area show a uniform, diffuse, rather marked narrowing, with rigidity and elongation. They are filled with medium rather than coated, while the terminal bronchi and alveoli are free of contrast. Six cases exhibiting this sign are presented.

Eight roentgenograms.

THEODORE E. KEATS, M.D.
University of California, S. F.

A General Hospital Admission X-Ray Program. Alfred L. Kruger, Philip B. Parsons, and Joe Lee Frank, Jr. Virginia M. Monthly **81**: 69–71, February 1954.

This report begins with a concise historical background for the utilization of survey chest studies. Detection—not qualified diagnosis—is stressed as of primary import.

In November 1947, a 70-mm. photofluorographic unit was installed in Norfolk (Virginia) General Hospital. The purpose was fourfold:

1. To examine every person admitted to the hospital when possible. In re-admissions the study is not repeated at less than six months. Infants, small children, traumatic and non-ambulatory cases were usually omitted.
2. To examine every new clinic patient.
3. To examine all personnel every six months.

4. To encourage practicing physicians in the city to send their patients for routine chest examination whenever they desire.

The unit was installed as close as possible to the admission office.

The present report covers a series of 43,967 film studies; 75.5 per cent were negative, 14.5 per cent showed significant cardiovascular abnormalities, 2.86 per cent revealed suspected reinfection tuberculosis, and 5.9 per cent showed other pulmonary lesions.

In general, the findings are appreciably similar to those obtained in larger centers and in Armed Forces and Veterans Administration studies. Survey studies are highly recommended for all general hospitals.

Two tables. JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Pulmonary Tuberculosis Following Gastrectomy. P. Rentchnick and M. Demole. Schweiz. med. Wchnschr. **84:** 591–595, May 22, 1954. (In French)

A new set of complications has followed in the wake of gastrectomy in subjects with cancer or gastroduodenal ulcer. Much has been written about the metabolic difficulties after this operation, such as the dumping syndrome and late postprandial hypoglycemia. Attention has also been called to the frequency of pulmonary tuberculosis after gastric resection. This can appear immediately after the operation, in a matter of days or months, or six to ten years later. The clinical and radiologic aspects of tuberculosis following gastrectomy offer no peculiarity. However, the process is generally progressive and severe and can result in death within several months. In ulcer patients not operated upon, on the contrary, the disease is often well tolerated.

A true anergy exists after the operation, which corresponds to a "stress" according to the concept of Selye in his general syndrome of adaptation. The early evolution of pulmonary tuberculosis in some postgastrectomy patients can be compared to that of tuberculous lesions following treatment with ACTH or cortisone, both of which provoke a phase of anergy in certain patients.

Most authors assign a fundamental role to the hypoproteinemia following gastrectomy both in the production and in the reactivation of pulmonary lesions. This effect of hypoproteinemia has been shown in the rat. The high incidence of pulmonary tuberculosis in prisoners-of-war, and in the poorly nourished in general, is further evidence in favor of this view, being higher than that which one would expect solely as a result of overcrowding.

Since it seems that the early appearance of pulmonary tuberculosis after gastrectomy is related to the operative "stress" and the later cases of tuberculosis are related to poor nutrition, the authors suggest certain prophylactic measures: preoperative radiographic study of the chest; particular postoperative attention to maintaining nutritional balance; attention to the postoperative weight curve. The ulcer patient with the proper indications for surgery should not be deprived of this merely because of healed or active tuberculosis. Decision to resort to surgery should be based upon the age of the patient and the relative importance of the ulcer and the tuberculous infection. If the ulcer is of prime importance and does not respond to medical treatment, it seems justified to intervene under cover of the antibiotics.

Included in the paper are 13 case histories of gastrectomy followed by early or late development of pulmonary tuberculosis, with a rapidly fatal issue in several instances.

Five roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Pulmonary Histoplasmosis in a Farm Family: A Three Year Follow-Up. C. G. Loosli, J. J. Procknow, F. Tanzi, J. T. Grayston, and L. W. Combs. J. Lab. & Clin. Med. **43:** 669–695, May 1954.

This paper documents in detail the changing clinical and laboratory findings of pulmonary histoplasmosis in 6 members of a farm family observed over a three-year period. The source of *H. capsulatum* was found in the silo which was cleaned by the father and two sons approximately three weeks before the onset of their illness.

The father had a severe prolonged illness, during which the fungus was found in the sputum and bone marrow. Two sons also had acute, extensive, but less severe pulmonary infections. Two daughters and another son had lesser pulmonary involvement and no symptoms.

Following recovery, the complement-fixation test became negative and the skin tests with histoplasmin, which had originally been negative, were consistently positive. The extensive disseminated pulmonary lesions of the father and his two sons healed by fibrosis and calcification. Calcification of the lung lesions occurred most rapidly in the younger son and most slowly in the father.

Twenty-one figures, including 12 roentgenograms; 7 tables. J. F. WEIGEN, M.D.
Palo Alto, Calif.

Surgical Significance of Solitary Circumscribed Lung Nodules in Histoplasmosis. Report of Three Cases. Don E. Matthiesen. Am. Rev. Tuberc. **69:** 829–836, May 1954.

The 3 "coin" lesions reported in this paper were found on routine chest roentgenograms in asymptomatic individuals. In each histoplasmin tests were strongly positive, and caseous material and organisms (*Histoplasma capsulatum*) were found in the lesions following surgical removal. Two of the solitary nodules contained enough calcium to be recognized in the chest films. In the other, calcification was microscopic.

It appears that histoplasmosis should be added to the list of considerations in the differential diagnosis of solitary pulmonary lesions. Surgical excision is felt to be a good method of treatment, since all of the lesions reported here contained viable organisms and 2 were not encapsulated.

Three roentgenograms. JOHN H. JUHL, M.D.
Minneapolis, Minn.

Pneumoconiosis in the Tungsten-Carbide Tool Industry. Report of Three Cases. Charles W. Miller, Martin W. Davis, Alfred Goldman, and John P. Wyatt. Arch. Indust. Hyg. & Occup. Med. **8:** 453–465, November 1953.

Three cases are presented of a peculiar type of pulmonary reaction and hyperglobulinemia in workers in the tungsten industry. The authors are quite certain that these 3 cases represent a type of pneumoconiosis. One worker improved radiologically after removal from the industrial environment, and in the other 2 the roent-

gen picture has remained virtually static over one year of observation. All 3 workers became asymptomatic after removal from exposure to dust. Tuberculosis would appear to have been adequately ruled out by negative tuberculin tests and negative sputum tests in all 3 cases, as well as negative guinea-pig tests in 2 cases. Sputum examinations and cultures in all 3 cases were negative for fungi. A possibility of sarcoidosis cannot be definitely excluded, but 3 cases from one small industrial plant would be unusual. Furthermore, the patients showed no cystic lesions of the hands and wrists, and the serum protein determinations were not typical of sarcoidosis.

The 3 patients were exposed to tungsten carbide, tantalum, titanium, cobalt, silicon carbide, aluminum oxide, and diamond dusts over a period of six to eight years. On the basis of their own investigations and those of others, the authors feel that the findings are attributable to cobalt.

Four roentgenograms; 2 photomicrographs.

Lipid Pneumonia Following Occupational Exposure to Oil Spray. Richard B. Foe and Roy S. Bigham, Jr. J.A.M.A. **155:** 33–34, May 1, 1954.

A case is reported to call attention to oil spraying as a cause of lipid pneumonia. The patient was a 30-year-old aircraft mechanic who had been cleaning aircraft engines with an oily spray (one-half kerosene and one-half vegetable oil soap) for eighteen months in a closed hangar. Weakness, dyspnea, and frequent "chest colds" were his chief complaints. Nodular densities of irregular size and shape were seen in both lungs but were much more extensive on the right. All other laboratory procedures were negative, so that lung biopsy was done to establish the diagnosis. Typical lipid pneumonia was seen (after which the occupational history was obtained). The patient was hospitalized for three months, with subjective improvement but no change in the x-ray picture. He then returned to duty and in three more months the lung fields were clear.

Two roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Atelectasis in Upper Respiratory Infections in Post-Traumatic Paralyzed Patients. Robert L. Friedman. Ann. Int. Med. **40:** 924–931, May 1954.

Pulmonary atelectasis occurs not uncommonly in post-traumatic paralyzed patients (more frequently quadriplegics than paraplegics) during an upper respiratory infection. The author reports 4 such cases seen within six months.

In paralyzed states there is a definite indication for chest x-ray examination at the first signs of an upper respiratory infection. It should be noted that the roentgen signs of atelectasis may be minimal. Follow-up studies seem advisable if the infection does not respond to routine therapy, since in the presence of atelectasis, special measures are indicated to avoid such further complications as pneumonia, abscess formation, and fibrosis.

Nine roentgenograms. STEPHEN N. TAGER, M.D.
Evansville, Ind.

Tuberous Sclerosis. Report of a Case with Unusual Pulmonary Manifestations. Charles M. Silverstein and George L. Mitchell, Jr. Am. J. Med. **16:** 764–768, May 1954.

The triad of adenoma sebaceum, mental retardation, and convulsions points to the diagnosis of tuberous sclerosis. This rare disease is characterized by a tendency to tumor formation with a predilection for the skin, brain, and eye, although involvement of practically every organ in the body has been recorded.

A case of tuberous sclerosis in a 25-year-old woman is believed worthy of reporting because neuropsychiatric symptoms were absent and involvement of the respiratory system was the most striking clinical finding. Asymptomatic "miliary" lesions in the lung of three years known duration were followed by spontaneous pneumothorax and death within one year. The authors were unable to find any mention of a similar case in the American literature, although pulmonary involvement by tuberous sclerosis has been reported in Europe (see Berg and Zachrisson: Acta radiol. **22:** 425, 1941; Samuelsen: Ibid. **23:** 373, 1942).

In 1949, the authors' patient was admitted to the hospital complaining of hypermenorrhea and anemia. She was seen to have "neurofibroma-like warty growths" on the face and body. At that time a chest roentgenogram showed small miliary densities throughout both lung fields, more marked in the bases. Over the next six months further diagnostic studies, including sputum tests and tuberculin skin tests, were negative, there was no change in the chest roentgenogram, and the patient gained weight; a diagnosis of sarcoidosis was made. In June 1950, the patient was admitted for hysterectomy; histologic examination showed leiomyomas of the uterus. Roentgen findings in the chest were unchanged. Thereafter the patient was asymptomatic until September 1951, when she was admitted to the hospital complaining of dyspnea associated with right-sided chest pain and cough. Examination revealed signs of a pneumothorax on the right, and this was confirmed by a chest roentgenogram. Other roentgen studies demonstrated the presence of intracranial calcifications, sclerotic lesions of bone, and multiple renal tumors. The findings on biopsy of some of the skin lesions were consistent with the dermal manifestations of tuberous sclerosis. The lung re-expanded without complications. The patient was readmitted three times during the next year with spontaneous pneumothorax involving either side. In December 1952, she complained of sudden chest pain and severe shortness of breath and died within two minutes. Autopsy was not permitted.

Four roentgenograms.

The Pulmonary Aspects of Polyarteritis (Periarteritis) Nodosa. Howard P. Doub, Ben E. Goodrich, and James R. Gish. Am. J. Roentgenol. **71:** 785–792, May 1954.

The authors present 19 cases of proved periarteritis nodosa. Of 8 patients in whom pulmonary lesions were seen postmortem, 6 showed roentgen evidence of lung involvement. While the roentgen findings are not specific, together with the history and clinical findings they may be suggestive of the diagnosis. They varied, in the cases mentioned, from hilar enlargement with increased bronchial vascular markings to extensive parenchymal infiltration occurring anywhere in the lung fields. In some cases, definite nodulation was visible; in others, there were bat-wing-like areas of infiltration extending out from the hilar areas. Cardiac enlargement and pleural effusion developed prior to death in some instances.

Seven patients in the series were alive and symptom-

free at the time of the report. In this group, pulmonary symptoms and roentgen abnormalities were neither frequent nor helpful in diagnosis.

The authors conclude, on the basis of their series, that major pulmonary symptoms or parenchymal roentgen abnormalities indicate a poor prognosis. They present a brief history of periarteritis nodosa, together with a discussion of the pathology and clinical characteristics.

Six roentgenograms. CLAUDE D. BAKER, M.D.
University of Louisville

Intrathoracic Pressure and Position of the Patient in the Roentgen Examination of the Mediastinum. Cesare Gianturco. Am. J. Roentgenol. **71:** 870–872, May 1954.

The roentgen changes in the appearance of the mediastinum produced by voluntary changes of intrathoracic pressure (Müller and Valsalva maneuvers) may be enhanced by the shifting of blood which occurs during sudden changes in positioning. To take advantage of this, the author combines the Müller test with the extreme Trendelenburg position and then observes the change in size and shape of the mediastinum when the patient assumes the erect position and performs a Valsalva maneuver.

Most of the changes occurring during this procedure are due to variation in the distention of the caval system of veins, but the different amounts of blood returned to the heart also cause the size of the heart, of the pulmonary vessels, and of the aorta to change in varying degrees.

The detection of paratracheal adenopathy probably represents the main indication for pressure-position studies. The localization of mediastinal masses may be facilitated by this means, and diagnostic conclusions are occasionally possible that would otherwise be difficult to obtain.

Six roentgenograms. THOMAS E. PADGETT, M.D.
University of Louisville

Roentgen Demonstration of the Organs and Tumors of the Posterior Mediastinum. E. Zierhut. Fortschr. a. d. Geb. d. Röntgenstrahlen **80:** 591–597, May 1954. (In German)

The author recommends the use of tomography, especially after air injection, as a means of improving the visibility of the normal and abnormal structures within the mediastinum. The use of air for double contrast gives better delineation and sharper differentiation of the various structures. Tomography is of value in isolating the individual area to be studied.

During the past year and a half, the author has used retroperitoneal air injection with no untoward result. The usual parasacral route has been employed, the needle being guided by a finger in the rectum, and 800 to 1,500 c.c. of air being injected. Positioning of the patient facilitates distribution of the air and it is important that its movement be followed under the fluoroscope. No food is allowed for four or five hours after study. Over one hundred cases have been examined by this method without accident.

As the injected air rises in the chest, the normal mediastinal structures and abnormal masses are visualized by double contrast, standing out very sharply. The lateral and oblique postures are especially recommended. After the exact position of the questionable mass has been determined, tomography is used routinely.

The following advantages have been demonstrated for this type of diagnostic procedure.

A. Differentiation between extra- and intrapulmonary tumors may be made.

B. Tumors of the esophagus may be studied as to their relationships, and adhesions to surrounding organs can frequently be determined.

C. The exact extent of esophageal and periesophageal tumors can often be determined.

D. Mass lesions impossible to demonstrate by the usual conventional methods can be identified, particularly in the posterior mediastinum, and may frequently be verified as metastatic.

Seventeen roentgenograms.

E. W. SPACKMAN, M.D.
Fort Worth, Texas

New Methods of Study in Radiology of the Mediastinum: Stratigraphy. Pietro Amisano. Proceedings of the Seventeenth National Congress of Medical Radiology, Italian Society of Medical Radiology, September 1952. (In Italian)

This monograph comes from the Department of Radiology at the University of Genoa, directed by Alessandro Vallebona. It therefore probably reflects the most current thought on stratigraphy.

The work is introduced by a history and geometric considerations underlying the various principles of the procedure in its various forms—uni-directional, pluridirectional, and transverse axial.

The transverse axial technic supplements plain radiography and frontal and sagittal stratigraphy, giving the observer a three-dimensional concept of conditions obtaining in the thorax. This allows an accurate definition of the normal and abnormal shadow, both as to size, shape, and relationship to neighboring structures. The technic is super-refined by inducing a pneumomediastinum, which brings the individual structures into bolder relief.

The results of such studies, constantly with emphasis on the transverse axial technic, are demonstrated by cases representing hypertrophy of the thymus, vertebral fracture, fibrothorax, lymphomatous tumors, postpneumonectomy state, neurinoma, aortic and common carotid aneurysm, and even such congenital cardiac anomalies as patent ductus arteriosus and tetralogy of Fallot.

The anatomico-pathologic information derived from this three-dimensional type of study is helpful not only in planning surgical intervention, but also in roentgen therapy for exact centering of cross-firing and of the tumor in the various rotation technics.

Seventy-nine illustrations, including 65 roentgenograms. CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Pneumomediastinum via Bronchoscopy. Experimental Research. S. Ingegnieros, A. Vago, and E. Zanetti. Radiol. med. (Milan) **40:** 468–487, May 1954. (In Italian)

The proposal of Schieppati (at the Second Argentinian Congress of Bronchoesophagology, August 1949) of a transbronchoscopic method of securing a biopsy of the lymph nodes in the bronchial bifurcation in cases of pulmonary tumor suggested the method of inducing pneumomediastinum described here. Only by the use of pneumomediastinum can a really adequate radiologic

and especially a laminagraphic study of the mediastinal organs be effected.

Gas injected in the anterior compartment of the mediastinum cannot diffuse into the posterior because of a dividing frontal fibrous septum. Gas introduced into the posterior compartment, on the other hand, can enter the anterior, since the aponeurotic sheath in the latter direction does not receive support from the vessels which are posterior to it and hence tears easily. A posterior pneumomediastinum, therefore, results in a total diffusion of the gas, while a pneumomediastinum induced anteriorly remains localized.

The indications for artificial pneumomediastinum are numerous: it not only confirms the presence of abnormalities already determined by ordinary radiologic means but also gives definite information about dimensions, contours, relations of neighboring organs, etc. Even failure of induction is informative, indicating an adhesive or productive process.

Since bronchoscopy is usually indicated in the same cases as artificial pneumomediastinum, it is reasonable to do the latter by way of the bronchoscope. The technic was evolved in seven dogs and consists essentially in the introduction of gas into the mediastinum by way of a cannula needle inserted through the bronchoscope and perforating the bronchial wall at the level of the carina. A two-way device is attached to the proximal end of the cannula, one outlet being for the pneumothorax apparatus and the other for a large syringe to ascertain that the needle is not in a blood vessel. After this is determined, 10 to 20 c.c. of air is introduced. If the manometer shows that the pressure oscillates with respiration, the insufflation is continued, since the needle is known to be in the mediastinum. After an initial rapid rise in pressure, one should wait to allow diffusion of air. After a few minutes the pressure is again negative. Periodic introduction of gas is continued until a final reading of about 10 cm. of water is reached. (The maximum quantity of gas introduced by the authors was 300 c.c.) The needle-cannula is then withdrawn.

A series of laminagrams in both the frontal and coronal planes is presented, comparing the appearances of the mediastinum with and without gas injection. The gas-filled studies demonstrate details of anatomy not apparent in the others.

Four of the seven dogs underwent the procedure well. One dog, in which angiocardiography was done in both the anteroposterior and lateral projections, died as a result of renal failure attributed to an excess of narcotic and contrast medium. In a sixth animal pneumothorax developed from the injection of too much gas within too short a time. The seventh exemplified a grave danger in this procedure, namely, puncture of the pulmonary artery, due to faulty technic.

The following precautions are listed as indispensable: (1) perfect local anesthesia; (2) disinfection of the area of puncture; (3) certainty that the needle is extravascular in position; (4) slow injection of the gas with frequent manometric control, to reach a constant positive pressure not exceeding 10 cm. of water; (5) roentgenoscopic control, especially in those cases in which there is no increase in pressure on continuing the injection of gas; (6) prophylactic administration of antibiotics.

Forty-one roentgenograms with accompanying line drawings; 4 photographs.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Exsufflation with Negative Pressure (E.W.N.P.). Elimination of Radiopaque Material and Foreign Bodies from Bronchi of Anesthetized Dogs. Hylan A. Bickerman, with the technical assistance of Sylvia Itkin. Arch. Int. Med. **93**: 698–704, May 1954.

Studies are reported on the effect of high expiratory flow rates achieved by exsufflation with negative pressure on the elimination of mucin-thorium dioxide (Thorotrast) mixtures and radiopaque foreign bodies from the bronchi of anesthetized dogs. The experimental procedure consisted in a slow inflation of the lungs, followed by an explosive "expiration," resulting in a total pressure-drop of approximately 100 mm. Hg, with expiratory flow rates that surpassed those attainable by the most vigorous cough of normal human subjects. A positive pressure blower served to inflate the lungs to a peak pressure of +30 to 40 mm. Hg over a period of two seconds. The expiratory phase was initiated by solenoid-activated valves, which cut in a negative pressure blower operating at a suction pressure of −40 to 60 mm. Hg. The resulting 100 mm. pressure-drop was attained in 0.02 second.

Bronchograms were taken immediately after instillation of the viscid thorium dioxide suspension thickened with gastric mucin and immediately following exsufflation. Approximately 75 per cent of the thorium dioxide mixture was eliminated in 8 dogs "coughed" an average of sixty times in ten to fifteen minutes, when the total expiratory pressure drop was 60 mm. Hg. Virtually complete elimination of the radiopaque material was effected in the remaining 12 animals "coughed" a total of thirty-six times in six minutes when the expiratory pressure drop was 100 mm. Hg.

Foreign bodies, consisting of lead shot, safety pins, and steel screws were inserted by a bronchoscope into the right main bronchus of 17 dogs. In 8 animals treated by exsufflation with negative pressure, within two hours after insertion of the metallic objects, complete elimination occurred after eighteen to thirty-six exsufflations. In 7 of the 9 remaining animals, treated for one to four days after the introduction of the foreign bodies, successful evacuation took place after approximately 24 "coughs." The 2 failures in this series were attributed to the foreign bodies becoming wedged in the bronchial tree.

Nine roentgenograms; 1 graph.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

THE CARDIOVASCULAR SYSTEM

An Appreciation of Mitral Stenosis. Part II. Investigations and Results. Paul Wood. Brit. M. J. **1**: 1113–1124, May 15, 1954.

A study of 300 patients with mitral valve disease revealed the following roentgen findings.

A small aortic shadow, though common in mitral stenosis, was found frequently with incompetence. Aortic valvular disease and atherosclerosis tended to preserve the aortic shadow.

Demonstration of left ventricular enlargement roentgenographically was a less reliable guide than clinical findings or electrocardiographic evidence.

Dilatation of the pulmonary artery was closely associated with pulmonary vascular resistance. Marked dilatation was seen in only one patient with mitral incompetence.

Right-sided cardiac enlargement (atrial and ventric-

ular enlargement being indistinguishable and therefore taken together) was closely associated with pulmonary artery dilatation. Exceptions to this were found in tricuspid stenosis, pericardial effusion, and "congestive heart failure."

Mitral incompetence produced a larger left atrium than mitral stenosis. There was no correlation between the size of the atrium and the degree of stenosis or the left atrial pressure.

Roentgenographic pulmonary venous congestion was proportional to left atrial pressure and the degree of stenosis. Success of valvotomy could be judged by relief of pulmonary venous congestion postoperatively.

Hemosiderosis occurred only in mitral stenosis. It had always been present for a long time and did not change following valvotomy. "Pulmonary apoplexy" had occurred four or five times more frequently in these patients.

Heavy calcification of the mitral valve was usually associated with serious incompetence. It is a drawback to valvotomy because of the severe destruction of the valve that is also present.

This paper includes also an account of the electrocardiographic, catheterization, and operative findings in the author's cases, as well as the results obtained.

Thirteen graphs; 7 tables.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

The Radiologic Diagnosis of Coarctation of the Aorta Without the Use of Contrast Media. L. Balli and G. C. Canossi. Radiol. med. (Milan) **40**: 439–467, May 1954. (In Italian)

With the ordinary chest technics of sagittal, lateral, and oblique projections and kymography, the radiologist can often diagnose coarctation of the aorta, as shown by a series of 11 cases reported here. The anatomical and clinical details of the condition are given, along with the various radiologic signs.

The authors call attention to the erosive defects on the under surface of the clavicle and at the neck of the scapula, as well as those in the ribs. They put much emphasis on two fundamental aspects of the vascular pedicle in this condition: (1) so-called "chimney aorta," due to absence of the aortic knob because of the fact that the aortic arch is more sagittal than usual; (2) the incisura on the left side of the superior mediastinum due to the intersection of the arcs of the supra- and infrastenotic segments of the aorta. At times, a second more cephalic incisura is seen, formed by the intersection of the arcs of the aortic knob and the dilated left subclavian or carotid artery leaving the arch and ascending into the neck. The effect upon the barium-filled esophagus of the dilated supra- and infrastenotic segments of the aorta is demonstrated, as well as the visibility of the internal mammary arteries.

The kymographic study of the infrastenotic aorta shows waves much smaller and distinctly different from those above the stenosis. By noting dicrotic pulsations in the kymographic tracing of the pulmonary artery segment, the authors believe that they could determine the patency of the ductus botalli: the first peak is due to the normal inflow of blood from the right ventricle, and the second to the inflow of aortic blood from the ductus, arriving somewhat later.

The actual coarctation can be demonstrated by laminagraphy, especially after an artificial pneumomediastinum.

Examination with contrast substance introduced *via* the veins or retrograde aortography should be reserved for those cases which present unusual clinical or radiological findings, resulting in diagnostic difficulties, or for those which require more detailed anatomic study in preparation for surgical intervention.

Twenty-six roentgenograms and drawings.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Solidography of the Heart. Shinji Takahshi and Tatsuyo Shinozaki. Acta radiol. **41**: 435–440, May 1954.

The authors present a technic, which they call "solidography," by means of which organs of the body can be molded. A stratographic, or rotatory cross-section, radiographic procedure is employed, with the tube focus and rotation axes of two rotation tables arranged in a vertical plane. A three-dimensional image is produced in a cassette box on one rotating table, similar to the actual body on the second table. As three-dimensional photosensitive film blocks are not as yet available, stacked films are used. Only the cross section of the body parallel to the film is depicted on each roentgenogram.

In the example described, 19 films, exposed in two series, were employed. From these films a plastic mold of the heart was constructed. The technic of construction is described in some detail. The authors consider the procedure to be simple, and the results to be of considerable value.

Four illustrations C. M. GREENWALD, M.D.
Cleveland Clinic

A New Kymograph for the Study of the Heart and Great Vessels. Gastone Meldolesi. Radiol. med. (Milan) **40**: 169–174, February 1954. (In Italian)

The author describes a new kymographic equipment with six separate recording devices. These devices can be oriented so that each is perpendicular to the contour to be studied. This gives a good representation of the motion of six points along the contour of the heart and great vessels.

Five roentgenograms; 1 photograph; 1 drawing

CESARE GIANTURCO, M.D.
Urbana, Ill.

Anatomic Variations in the Coronary Arteries. An Arteriographic Study in Living Subjects. Lucio di Guglielmo and Mariano Guttadauro. Acta radiol. **41**: 393–416, May 1954.

In this excellent paper the authors present an analysis of anatomic variations in the coronary arteries based on the literature and their own material of 399 examinations on 292 patients (192 thoracic aortographies and 207 angiocardiographies). They group the variations according to the following scheme:

Variations in number
- (*a*) Increase
- (*b*) Decrease

Variations in origin
- (*a*) Anomalous position in the sinus arteriosus
- (*b*) Origin in the ascending aorta
- (*c*) Origin in other arteries

Variations in the mode of division and distribution
- (*a*) Variations in division: increase
- (*b*) Variations in division: decrease

(*c*) Variations in the individual branches of the left coronary artery
(*d*) Preponderance of one coronary artery

In 145 patients of their own series, in whom contrast filling of the coronary arteries was obtained, the authors found no variation in the number of the vessels of the heart, nor any significant variation in their origin.

The variations of division and distribution most frequently encountered are those of the left coronary artery. It was possible to confirm both increases in its division, (three branches) or decreases (presence of a single tract). The series also revealed variations in the two large branches of the left coronary artery, a single example in the case of the anterior interventricular branch, and a greater number in the circumflex branch.

The conception of the preponderance of one coronary artery may be confirmed in living subjects; the preponderance development of a coronary artery is substantiated radiologically only when it is clearly evident that such an artery gives rise to one or more important ramifications which normally arise from the other coronary artery and, therefore, supplies a more extensive area than normally. Out of 117 cases in which the branches of the left coronary artery were visible, the authors observed in 11 (9.4 per cent) the division of the left coronary artery into three branches. As it was difficult to obtain complete contrast filling of the whole coronary circulation, the vessels in the region of the crux being the most difficult to visualize, the material did not permit a statistical analysis of the preponderance of one coronary artery. It seems, however, that the preponderance of the right coronary artery is more frequent than that of the left. This would agree with the anatomic findings; according to Schlesinger there is preponderance of the right coronary in 48 per cent of cases and of the left in only 18 per cent.

Variations in the coronary artery do not appear to be particularly frequent.

Fourteen roentgenograms, with explanatory diagrams; 7 drawings.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Visualization of the Coronary Veins During Angiocardiography. A. Aguzzi, L. di Guglielmo, V. Baldrighi, and A. Marley. Radiol. med. (Milan) **40**: 140-146, February 1954. (In Italian)

During the course of angiocardiography done by means of an intracardiac catheter, the authors obtained a beautiful demonstration of the coronary venous system. They attributed this unusual result to the high pressure under which the contrast medium was injected and to the fact that the tip of the catheter was opposite to the opening of the venous channels. The patient suffered no ill effect.

Three roentgenograms; 1 drawing.

CESARE GIANTURCO, M.D.
Urbana, Ill.

Temporary Unilateral Occlusion of the Pulmonary Artery. A Method of Roentgen Examination of the Pulmonary Vessels. Björn Nordenström. Acta radiol., Suppl. 108, 1954.

The circulation of one lung can be blocked in the living subject by means of a small rubber balloon attached at or near the tip of a double-lumen cardiac catheter. During temporary unilateral occlusion of a pulmonary artery, radiopaque medium may be injected and the ipsilateral or contralateral lung may be studied by roentgen examination of the pulmonary vessels. In this monograph the author tells of the development of a method of roentgen examination of the pulmonary vessels utilizing such a technic. One hundred and forty-four experiments were conducted on 83 dogs, and examinations were made in 17 patients.

In the first part of the report the anatomy of the pulmonary vessels is reviewed, with a listing of the nomenclature as applied to the dog. There is a description of the roentgen apparatus, and details are included of the circuit arrangement of the electrokymograph which was used in recording roentgen absorption in the lungs and of the construction of the various cardiac catheters that were employed. Information is also supplied as to drugs and contrast media, amounts and modes of administration of anesthetics, and the general technic of the histologic examinations.

After the cardiac catheter has been inserted and guided, under fluoroscopy, to a proper position for occlusion of the desired vessel, 35 per cent iodopyracet is injected to fill the small balloon which produces occlusion. The position, shape, size, and movements of the balloon are therefore readily observed and may be properly adjusted. The initial injection of contrast liquid distal to the occlusion can be made to fill the gap between balloon and vascular wall and remain there, thus furnishing an indication of the completeness of the obstruction. Heparinization of the blood was employed routinely to prevent the formation of small clots at the edge of the balloon.

Preliminary studies indicated that in just under half the experiments the pulmonary arteries distal to an occlusion were narrower in caliber than those of the opposite side. Densograms of the lung obtained by means of the electrokymograph revealed a decreased roentgen-ray absorption in a lung after occlusion of its artery, in every instance. This was attributed to the decreased blood content.

Small volumes of contrast material (it was unnecessary to use higher concentrations than 35 per cent iodopyracet) were sufficient to obtain readable angiograms of the pulmonary arteries. The volume determined to be adequate was 0.2–0.3 ml. per kilogram of body weight. The factors contributing to the disappearance of contrast medium injected distal to an occlusion are discussed.

There are two methods of obtaining angiograms of the bronchial arteries in the living dog. In one method, the thoracic aorta is occluded below the origin of the bronchial arteries and contrast medium is injected proximal to the occlusion. In the second method, the bronchial arteries of the right lung alone may be visualized by retrograde injection of the 6th right intercostal artery. The latter procedure demonstrated communication between the bronchial and pulmonary vascular systems. Selective venograms may be obtained, preferably during suspended respiration induced by curarization, by injection distal to a rather deeply placed segmental pulmonary artery occlusion where there is an essentially capillary perfusion.

On the basis of the preliminary experimentation, the methods of unilateral angiography of the pulmonary arteries were tested in 9 dogs. Postmortem studies of pulmonary vessels and lung parenchyma were conducted on this group. With use of a soft-tipped catheter, the only observable postmortem effect was a slight

edema of the vessel wall at the site of the occlusion due to pressure, deemed to be unimportant. The main risks of both proximal and distal injection of the pulmonary vessels with arterial occlusion are those concerned with cardiac catheterization. Contrast filling of the veins of an occluded lung was usually obtained when medium was injected proximal to the occlusion in angiography of the contralateral lung. This was apparently due to the contraction of the left auricle forcing the medium backward to the veins of the occluded lung.

In the study of 17 patients injection was made proximal to the occlusion in 2 instances (see J. Thoracic Surg. **22:** 527, 1951. Abst. in Radiology **59:** 595, 1952). Fifteen patients had injection distal to the occlusion and 5 clinical case reports of this group are presented. The method has found application in pulmonary arteriovenous aneurysm, embolism and infarction, middle lobe syndrome, and emphysema. The ultimate value in clinical application depends on further study. The author's group is too small to warrant valid conclusions. In this group the only complication was a transitory paresis of the median cubital nerve in 1 instance, probably related to exposure of the vein.

Usual roentgen technics are satisfactory for pulmonary angiography. Rapid serial roentgenography may be used, as well as biplane studies. This treatise represents a rather detailed project which has been well executed. There are many practical and important technical hints and suggestions which cannot be summarized. Anyone interested in the application of this method should consult this work in the original.

Ninety-six roentgenograms, as well as photographs, diagrams, and graphs.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Spontaneous Partial Occlusion of the Innominate Artery: Report of a Case with Angiocardiographic Confirmation. Nicholas P. Christy, Lowell G. Lubic, and Melvin D. Yahr. Ann. Int. Med. **40:** 1040–1048, May 1954.

The occurrence of innominate artery occlusion without known underlying intrinsic disease of this vessel or neighboring vessels is believed not to have been previously described. The authors report a recently observed case in a 40-year-old white female, in whom angiocardiographic confirmation was obtained. This is thought also to be the first recorded case of innominate artery obstruction to be established roentgenographically.

The recurrent character of the symptoms, the lack of clinical right optic nerve involvement, and partial filling of the right common carotid demonstrated by the angiocardiographic study, all seemed to indicate an incomplete rather than a total occlusion of the innominate artery. The symptoms and signs of right hemispheric encephalomalacia which were present can be explained by the demonstrably reduced right common carotid artery blood flow resulting from incomplete obstruction. Since no underlying disease was demonstrated, the findings are believed to represent a spontaneous thrombosis. The most likely basis for thrombosis is statistically an arteriosclerotic plaque in the intima of the vessel. This can be neither proved nor excluded on clinical grounds.

The important point is that the picture of an "ordinary" cerebral vascular accident is here produced by an unusual vascular lesion. Though carotid artery thrombosis is the more frequent cause of extracranial vascular involvement, occlusion of more proximal blood vessels, such as the innominate, may occasionally give rise to a similar picture. The distinguishing feature of innominate involvement is the occurrence of decreased pulse volume and lowered blood pressure in the homolateral upper extremity, in addition to loss of homolateral common carotid pulsation and contralateral hemiparesis.

A routine examination of extracranial arteries in cases of cerebral vascular insufficiency may thus uncover local or generalized vascular disease, giving new implications to lesions thought at first to be solely intracranial.

Four roentgenograms; 2 drawings.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Our Experience with Percutaneous Lumbar Aortography. A. Temesvári and St. Jóna. Schweiz. med. Wchnschr. **84:** 564–566, May 15, 1954. (In German)

After giving due credit to Portuguese and American workers for the development of aortography, the authors state that they have introduced this method to Hungary only recently. Their technic is described in detail and differs little from that practiced in the United States, with one exception: two cassettes are placed in tandem on the radiographic table, with the tube at such a distance that a single exposure covers both. This makes possible simultaneous visualization of abdominal and thigh vessels with one injection.

Up to October 1953, 40 patients had been subjected to percutaneous lumbar aortography in the Department of Surgery of the University of Budapest (20 for endarteritis obliterans, 16 for atherosclerosis, and 4 for preoperative and postoperative studies of aneurysms). Each patient received 30 to 50 c.c. of 70 per cent Joduron. The only major complication was one para-aortic injection which produced pain subsiding after twenty-four hours. A twenty-four hour film failed to demonstrate residual contrast material in the soft tissues.

Whenever extravasation is suspected, the needle is left in place and 100 to 200 c.c. of physiological saline injected through it. The films are then checked in the dark room for evidence of para-aortic contrast material and 50 to 100 c.c. of 0.25 per cent novocaine solution is introduced through the same needle if indicated.

A case of successful removal of a thrombus from the left common iliac artery is reported and illustrated by preoperative and postoperative angiograms.

GERHART S. SCHWARZ, M.D.
New York, N. Y.

Vessel Closure in Carotid and Vertebral Angiograms. K. Decker and E. Holzer. Fortschr. a. d. Geb. d. Röntgenstrahlen **80:** 565–575, May 1954. (In German)

The authors obtained carotid and vertebral angiograms by the usual percutaneous technic, with Per-Abrodil-M (45 per cent). Eight cubic centimeters was injected at a time, care being taken not to exceed 25 c.c. for one study. It is most important to have the needle well within the vessel lumen. Injection into the vessel wall not only gives a poor result but may be dangerous if an acute condition is present within the artery of the opposite side. The authors have observed hemiplegia and death in such an instance.

In the anteroposterior view, rotation of the head to the opposite side is helpful for identification of details of the middle cerebral artery. Caudal angulation of the x-ray tube, paralleling the base line of the skull (orbitomental), projects the middle cerebral vessels into the orbits and is used either in the anteroposterior or postero-anterior positions. Where closure of the anterior division is suspected, compression of the opposite carotid is recommended. Closure of the posterior division is difficult to demonstrate and is rarely shown by carotid injection. Vertebral artery injection is usually required to demonstrate this vessel.

Spasm and occlusion of the carotid artery in the neck are relatively easily recognized. The roentgenogram shows the site of occlusion and occasionally the extent of closure and collateral circulation; it may demonstrate emboli in the finer distal arterial divisions. Localized thrombosis of the neck vessels may not lead to occlusion but can be the cause of brain emboli without any pathological changes in the heart.

From 1948 to 1953 the authors studied 97 cases of arterial occlusion. Thirty-five cases showed involvement of the carotid in the neck region, the majority just above the bifurcation and many involving the external carotid also. There were 7 examples of closure of the intracranial portion of the carotid, associated especially with syphilis. In 42 cases isolated closure of the middle cerebral was observed, giving the least difficulty in diagnosis. The anterior and cerebral arteries were occluded in 2 instances, and the posterior cerebral in 1. In at least one-half of the authors' cases, a "late arterialization" was shown on the venous phase of the study. This is considered significant for confirmation of the diagnosis.

The authors emphasize the importance of the collateral circulation. The older idea of end arteries in the brain, they believe, should be completely abandoned as neither anatomically or functionally correct. Multiple closures were occasionally observed, with correspondingly poor prognosis. Relatively few vessel closures were observed in the posterior regions by vertebral angiography.

Follow-up angiography is particularly recommended for correlation with the clinical and physical aspects of the cases.

Eleven roentgenograms. E. W. SPACKMAN, M.D.
Fort Worth, Texas

Bilateral Carotid-Cavernous Fistula. T. H. Mason G. M. Swain, and H. R. Osheroff. J. Neurosurg. **11**: 323-326, May 1954.

A case is reported in which the surgical treatment of bilateral carotid-cavernous fistulas was dictated by repeated angiography.

An 18-year-old soldier sustained a head injury in a motorcycle accident and was admitted to the hospital in coma and shock, with signs of *right* 6th nerve paralysis, a bilateral Babinski sign, and bleeding from the nose and right ear. After a week of agitation and disorientation, a proptosis was noted on the right. A bruit was now elicited over both eyes, more marked on the right, and *left* 6th nerve paralysis was apparent. Skull films were negative for evidence of fracture.

Bilateral angiography by percutaneous injection of the carotids revealed a *right* carotid-cavernous fistula and a normal circulation on the left. After ligation of the right internal carotid the bruit on the right was markedly diminished. The bruit on the left increased, however, and angiography was repeated on that side, revealing a *left* carotid-cavernous fistula. After an intracranial clipping of the right internal carotid artery, the left internal carotid was ligated. Subsequent left external carotid angiography showed a retrograde filling of the fistula on this side through the ophthalmic artery, and because of this the left common carotid was ligated. Thirty-two days after this surgery, both bruits had disappeared and the patient was in good health except for bilateral 6th nerve paralysis and anesthesia over the distribution of the ophthalmic and maxillary nerves.

Why the left arteriovenous fistula did not appear radiographically until ligation of the right internal carotid is a matter of speculation. The suggestion is made that it may be explained by some change in intravascular pressure secondary to initial carotid occlusion and the opening of a healing intracavernous-carotid tear. The potent collateral circulation was demonstrated by visualization of retrograde filling of the cavernous sinus through the external carotid system.

Five roentgenograms. JOHN F. RIESSER, M.D.
Springfield, Ohio

The Relationship of Bony Processes to Changes in the Blood Vessels. R. Seyss. Radiol. clin. **23**: 129–136, May 1954. (In German)

The roentgenologic diagnosis of diseases of bony tissue is particularly difficult because of its limited modes of reaction, namely, bone destruction and bone proliferation, or various mixtures of the two. The diagnosis is especially difficult when one of these reactions predominates.

Three diseases with a predominantly osteolytic picture are scleroderma, psoriatic arthritis, and syringomyelia. The present report includes 4 cases of scleroderma, 2 of psoriasis, and 2 of syringomyelia, in all of which studies were made of the blood vessels of the upper extremities. Arteriographic exposures were made every three seconds following injection of a contrast medium. The injection was made percutaneously, with a needle of the same caliber and with the same speed of injection in all cases. The same severe disturbance in circulation was found in all three conditions. This disturbance resembled that found in obliterating endangiitis: narrowing of the arterial lumen, slowing of the blood stream, tapering of the ends of the vessels, lack of filling of the digital arteries, lack of capillary division in the fingertips, and rapid transit into the veins. An important point is made of this last. Some regard it as due to arteriovenous anastomoses, which have been demonstrated anatomically and probably even arteriographically. The author has seen rapid transit into the veins frequently in other diseases. The significance of the phenomenon is that the oxygen-saturated blood does not reach the tips of the fingers, and impaired nutrition of the tissues results.

Syringomyelia has the surest anatomic foundation of these three diseases, being primarily a disease of the spinal cord, with secondary blood vessel changes. There is also some evidence that scleroderma is neurologically determined. The etiology of psoriasis is still much debated, some even subscribing to a neurogenic origin. There are indications of vegetative neural disturbances, with secondary vascular changes, in all three of these conditions.

The results of this study are not taken to mean that every osteolytic bony change stems from an impaired circulation to the bony tissue. The circulation is in-

creased, for example, in the region of a bony metastasis and in post-traumatic bone atrophy.

Ten roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Body Position in Relation to Venous Air Embolism: A Roentgenologic Study. Thomas M. Durant, M. J. Oppenheimer, Peter R. Lynch, Guido Ascanio, and Donna Webber. Am. J. M. Sc. **227:** 509–520, May 1954.

The authors have shown in previous studies (Am. J. M. Sc. **225:** 362, 1953) that fatal venous air embolism is less likely to occur in dogs if the animal is in the left lateral decubitus position before or soon after the injection of air. The present investigation confirms this finding with use of the biplane stereoscopic angiocardiographic device developed by Chamberlain and co-workers. After the injection of 7.5 c.c. of air per kilogram of body weight into the femoral vein, 6 animals were studied in the left lateral position, and 4 in the supine position. Blood pressure and respiratory records as well as blood oxygen and carbon dioxide determinations were correlated with serial biplane roentgenograms. Three of the 4 animals in the supine position died, and 4 of the 6 animals in the left lateral position survived.

Roentgenograms obtained in the left lateral position showed that the injected air accumulated in the most superior part of the right heart, away from the outflow tract of the right ventricle, thus favoring continuity of blood flow into the lungs. In the supine position the air accumulated in the main pulmonary artery and outflow tract of the right ventricle, effectively blocking the flow of blood. The buoyancy of the air accounts for its location in each position. In the left lateral position the air was gradually eliminated from the right ventricle and right atrium by contraction of the heart and by inspiratory aspiration. Most of the air entering the lung proceeded through the right pulmonary artery, since this was superior in position. In the supine position the air in the outflow tract remained there in those animals that succumbed. At necropsy, the animals which recovered from the procedure had no air in the heart or great vessels twenty to thirty minutes after injection, whereas the fatal cases showed air in the right heart as well as in the pulmonary arteries and vena cava. The trapped air in the right ventricle and pulmonary artery had apparently caused circulatory collapse.

The authors describe a human case of air embolism occurring during angiocardiography. The patient was in a sitting position. Air was accidentally sucked into the vein when a syringe was disconnected. The patient collapsed and was unresponsive for two minutes, after which there was complete recovery. Roentgenograms showed that about 10 to 20 c.c. of air was trapped in the pulmonary artery and its left main branch.

In the treatment of accidental air embolism the authors suggest not only immediate placement in the left lateral position but artificial respiration. This helps inspiratory aspiration of the air in the right heart. If these measures are ineffectual, needle aspiration of the right atrium is suggested.

Ten roentgenograms; 1 blood pressure curve.

D. D. ROSENFELD, M.D.
U. S. Naval Hospital, Oakland, Calif.

Transparietal Splenoportography. G. F. Leroux and A. de Scoville. J. belge de radiol. **37:** 89–137, 1954. (In French)

This work represents a rather extensive review of clinical and experimental portal venography with especial reference to transparietal splenoportography. Since hepatic deficiency will be suspected in most of the patients undergoing this study, clinical tests to determine efficiency of blood clotting should be applied. Administration of substances to encourage normal coagulation appears judicious. If ascites is present, the fluid should be withdrawn. The intradermal sensitivity test is carried out with 0.1 to 1.0 c.c. of the contrast agent.

Morphine is administered before the procedure. With the patient lying down, the contour of the spleen is determined by palpation and percussion. The skin at the puncture site is anesthetized with Novocaine. Injection is usually made through the eighth or ninth intercostal space anteriorly. A 12-caliber needle about 16 cm. in length is used. From 25 to 35 c.c. of 70 per cent Xumbradil (similar to iodopyracet, U.S.P., Diodrast brand) is injected in four seconds. Immediately after the injection, the first film is taken. Seven films are obtained within one and a half to two seconds.

The authors' series consists of 19 cases representing various pathologic states. The procedure produced no unusual side-effects and yielded much information. Thrombosis of the splenic vein, varices of collateral veins, and deformities of the extrahepatic splenoportal trunk produced by tumors of the pancreas, antropyloric segment, and of the biliary tract, were well demonstrated. Visualization of the liver (hepatography) aided in the demonstration of metastatic cancer and cirrhosis.

Twenty roentgenograms.

CHARLES M. NICE, JR., M.D.
University of Minnesota

Changes of the Axillary Vein After Radical Mastectomy. P. E. Russo, J. M. Parker, and H. H. Mathews. South. M. J. **47:** 430–435, May 1954.

In a paper delivered at the 1951 meeting of the Radiological Society of North America and subsequently published in Radiology (**59:** 538, 1952), Parker, Russo, and Osterreicher described an investigation of the cause of lymphedema of the upper extremity after radical mastectomy. This work has been continued. In the present paper the authors review briefly their technic for the study of this problem and summarize their findings in 15 cases in which a radical mastectomy was the only procedure. They employ venography, venous pressure determinations, and arm measurements. Their conclusions are as follows:

(1) After a radical mastectomy changes in the axillary vein can be demonstrated, varying from a mild degree of distortion to a complete occlusion.

(2) These changes are probably inflammatory in nature, thrombotic, phlebitic, or thrombophlebitic, since in most instances the axillary vein may be restored to its normal caliber and appearance after a period of three to four months. Since in all the authors' cases the arm was bandaged with Elastoplast as a prophylactic measure, it is impossible to say whether or not the axillary vein would have returned to its normal size in that period of time if bandaging had been omitted.

(3) The rise in venous pressure as a rule closely

follows the degree of changes seen in the axillary vein after operation. Three to four months postoperatively the vein begins to assume its normal appearance and a drop in pressure occurs. In those cases in which the vein remains permanently deformed or occluded, the venous pressure remains elevated.

The authors are convinced that lymphedema of the arm and changes in the axillary vein are closely related. If prophylactic bandaging of the arm gives the vein a better opportunity to recover following surgery, then it is a worth-while procedure.

Twenty-one roentgenograms, illustrating 6 cases.

An Evaluation of Venography and Venous Pressures in the Study of the Leg Veins. H. D. Moore. Brit. J. Surg. **41**: 633–639, May 1954.

This is a report on 33 legs examined by ascending and descending venography (with Diodone) and by determination of venous pressures in the feet with the patient standing still, standing/walking, and standing/walking with a tourniquet below the knee to occlude the superficial veins. The object was to see if the results of the three procedures agreed, and to try and assess the value of venography in the legs, as a whole, and the relative values of the ascending and descending methods.

Twenty-one of the 33 legs examined were without symptoms except for superficial varicose veins. In these, all three tests were normal. In 9 legs there had been symptoms of the gravitational syndrome, relieved by ligation of the superficial veins alone or in conjunction with mild support in the form of elastic stockings. The venograms were relatively normal in these cases also, but in 3 instances the venous pressures dropped slightly less than in the relatively normal legs.

Three legs with symptoms of the gravitational syndrome and with a history of previous deep venous thrombosis gave abnormal ascending venograms, probably abnormal descending venograms, and no pressure drop when the superficial veins were occluded.

The findings of the three tests were usually in agreement. If any of the three is unequivocally normal, then that finding may be taken as valid, but if a finding is abnormal or if its normality is arguable, it is unwise to rely on one test alone. The venous pressures are the most reliable index of the state of the veins. When the veins are normal, however, the changes in pressure may not be sufficiently great to establish the normality, and if the veins are abnormal the pressures do not indicate the nature of the abnormality.

On the basis of his observations, the author feels that "venography should not be the first approach to the study of the veins of the legs, but that it should be used in all cases where the venous pressure readings show a definite abnormality or are doubtful, and that ascending venography should be used before descending, the descending method being reserved for those cases which are not clear after the venous pressures have been taken and ascending venograms made."

Twenty-one roentgenograms; 3 tables.

PAUL MASSIK, M.D.
Quincy, Mass.

Reaction to Contrast Substances in Angiography. H. Felten. Fortschr. a. d. Geb. d. Röntgenstrahlen **80**: 575–580, May 1954. (In German)

Numerous reactions have been observed in routine angiography, similar to those reported in urography. Of the milder types, the most common have been vomiting, dizziness, headache, urticaria, and edema. The more severe reactions have included laryngeal edema, cyanosis, circulatory failure, syncope, and collapse. Per-Abrodil-M is used in the author's clinic because of its relative freedom from unfavorable effects.

One of the reasons for the reactions observed in angiography is probably the large quantity of contrast material used. Occasionally the arterial systems of both legs are injected, particularly in cases of obstruction of the iliac artery. In about one-third of the author's cases, a mottled erythema appeared during the injection, followed in a few seconds by a rather intense reddening of the entire extremity, especially if a second injection were given. Occasionally the reaction may be delayed for several minutes. This the author considers a warning sign, as it has frequently preceded the more serious symptoms listed above.

Ziperman, Hughes and Shumacker (Angiology **1**: 427, 1950. Abst. in Radiology **58**: 311, 1952), in experiments on overdosage with Diodrast in mice, demonstrated that morphine and ether increased the death rate of the animals; Evipan had no influence, and Veronal-Sodium and Nembutal decreased the effect of the medium. The author prefers local anesthesia. Some pain incident to vessel dilatation is frequently present but is not considered significant.

A congenital sensitivity appears to be the underlying basis of the reactions; a true acquired sensitivity would seem to be extremely rare. The usual sensitivity tests (eye, mouth, intradermal, etc.) are not considered accurate, and the author believes that routine prophylactic use of antihistamines is of little value. The intra-arterial introduction of 2 c.c. of the German preparation Neo-Bridal after the appearance of the reaction, however, gave immediate relief of subjective and objective symptoms. After disappearance of the reaction, the examination may be continued.

In a series of 200 cases, in many of which 50 gm. or more of contrast material were injected, the author observed only a small number of reactions due to the medium, and these were easily controlled.

E. W. SPACKMAN, M.D.
Fort Worth, Texas

THE DIGESTIVE SYSTEM

Cardioesophageal Relaxation in Infants. Kurt Glaser, Emil Freundlich, and A. Schwartz. Am. J. Dis. Child. **87**: 586–593, May 1954.

Three cases are reported in which esophageal chalasia constituted the clinical problem and was demonstrated radiographically. The youngest child was one month of age, the oldest six and a half months. Whether regurgitation is normal in infancy is controversial. Therefore, 33 infants between three days and eight months of age were studied by the same fluoroscopic technic which was used in the cases of chalasia. In none of these 33 infants was regurgitation demonstrated.

Recurrent vomiting when the child is placed flat on his back after meals is the primary symptom of cardioesophageal relaxation, usually occurring soon after birth. The child may be hungry and well developed or, in extreme cases, malnourished or even dehydrated. A swallow of a thick paste of barium discloses, in the erect position, a dilated esophagus with sluggish peristalsis. With the patient supine, when the stomach is filled with barium, material returns into the esophagus through a

wide cardioesophageal orifice. Treatment consists in maintaining an upright position for some hours after the meal. Gradually, over a period of months, this may be decreased.

In neglected cases, esophageal dilatation and ulceration occur, and there will be old blood in the stools and fresh blood in the vomitus. The ulceration and dilatation of the esophagus increase the incompetence of the closing mechanism of the cardia.

Differentiation from sliding hiatus hernia can be established by locating the gastroesophageal junction. If the junction is seen under the diaphragm on repeated examinations, a sliding hiatus hernia is excluded.

Ten roentgenograms.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

The Esophagus in Radiologic Problems. Robert K. Arbuckle. California Med. **80**: 360–362, May 1954.

This is a brief systematic review of the possibilities and potentialities of radiologic examination of the esophagus and a report, in detail, of 4 illustrative cases. One point not commonly mentioned is demonstration of fixation of the esophagus by mediastinal lymph nodes. This is accomplished with the aid of the Trendelenburg position to display the rigid tube-like appearance of the esophagus with loss of normal distensibility.

Four roentgenograms.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Rupture of Stomach, Spleen, and Left Hemidiaphragm. Saul Swartzbach and Jerome E. Curtin. Am. J. Dis. Child. **87**: 616–620, May 1954.

An automobile ran over a five-year-old child, who was then seen with a flat, splinted, tender abdomen. An upright film showed air under the diaphragm on both sides, elevation of the diaphragm on the left, absence of the splenic shadow, and a small pneumothorax in the left side of the chest. The preoperative diagnosis was rupture of the spleen and a hollow viscus.

The significance of the air in the left hemithorax was not appreciated in this case. Splenectomy was done for the ruptured spleen, and a hole 10 cm. in length was found in the fundus of the stomach. Laceration of the left diaphragm was also encountered.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

The Roentgen Differential Diagnosis of True Transpyloric Gastric Mucosal Prolapse. W. Frik. Fortschr. a. d. Geb. d. Röntgenstrahlen **80**: 587–591, May 1954. (In German)

Prolapse of the pyloric mucosa through the sphincter presents a common and frequently puzzling problem. Symptoms may be entirely absent or too vague to permit a diagnosis. Differentiation from adult pyloric hypertrophy and edema of the duodenal mucosa becomes most important from both the diagnostic and therapeutic standpoints.

The author describes a new x-ray sign that he regards as characteristic of mucosal prolapse. This consists of narrow, elongated borders along the lateral contour of the base of the duodenal cap, lying between the prolapsed mucosa and that of the bulb. This zone is sharply pointed and directed toward the pyloric canal (Fig. 1). Simple impression on the base of the cap causes a sharply defined but more blunt and less elongated border, directed toward the stomach (Fig. 2).

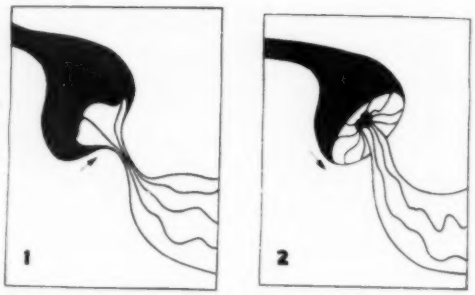

Fig. 1. Transpyloric gastric mucosal prolapse. Point of the contrast material margin directed toward the pyloric canal.

Fig. 2. Impression on the base of the bulb. Point of contrast material margin directed to the stomach.

The other commonly recognized signs of mucosal prolapse are discussed, but the author has found that in a number of cases these are not sufficiently marked to be diagnostic.

Eight roentgenograms; 2 drawings.

E. W. SPACKMAN, M.D.
Fort Worth, Texas

Further Radiological Studies of the Movements of the Jejunum in Man, with Special Reference to Steatorrhoea. G. M. Ardran, J. M. French, and J. W. McLaren. J. Fac. Radiologists **5**: 267–275, April 1954.

Observations of the motility of the small intestine were made in 33 normal patients, in 17 cases of idiopathic steatorrhea, and in 7 cases of tropical sprue, by direct serial radiography. No severe cases were included in the series. Both flocculating and non-flocculating suspensions of barium sulfate were used.

Observations of the types of movement in the normal subjects examined with colloidal non-flocculating suspension confirmed those previously found with the use of a simple flocculable suspension in normal saline (see McLaren *et al.*: J. Fac. Radiologists **2**: 148, 1950. Abst. in Radiology **57**: 454, 1951).

The types of movement in steatorrhea with flocculable and non-flocculable suspensions were compared. Flocculation of the medium prevented an accurate examination of intestinal motility. With colloidal barium the types of movement were found not to differ from the normal, except that there appeared to be some diminution in the frequency of progressive segmentation. There was an increase in caliber of the small intestine in many of these cases.

The study of the action of a number of drugs with the serial radiographic method gave indefinite results, and emphasized the severe limitations of the method due to radiation hazards.

Twenty-eight roentgenograms.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

The Effect of Peroral Barium in Partial Obstruction of the Small Bowel. An Experimental Study. Henry Donato, Henry W. Mayo, Jr., and L. H. Barr. Surgery **35**: 719–723, May 1954.

High-grade partial obstruction of the terminal small

bowel was produced in 38 unselected dogs by encircling the bowel with reactive cellophane. The lumen was usually narrowed at the site of obstruction to about 3 to 6 mm. diameter. This was sufficient to result in dilatation of the proximal small bowel for a distance of 30 to 40 cm.

Sixteen of these dogs were studied roentgenologically by use of barium administered through a Levin tube, followed by serial films. The animals were then autopsied and the character of the bowel contents and size of the lumen were correlated with the roentgen findings.

In no case was complete obstruction produced by barium impaction. The barium, in fact, tended to become more fluid during the period of stasis in the dilated proximal bowel.

The authors feel that, after obstruction of the colon has been ruled out, the administration of barium by mouth to patients with chronic partial small bowel obstruction is safe.

Three roentgenograms; 2 photographs.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

Hirschsprung's Disease. Roentgen Diagnosis in Infants. Raymond G. McDonald and William A. Evans, Jr. Am. J. Dis. Child. **87**: 575–585, May 1954.

The x-ray diagnosis of Hirschsprung's disease in infancy requires a study of evacuation of the enema and detection of a persistent disparity in caliber between two segments of the colon. Since the normal infant colon shows a marked degree of distensibility in response to the hydrostatic pressure employed in barium enema examination, the degree of distention or elongation during the examination is of no diagnostic significance. It is of significance to report at what level the dilatation (persisting on evacuation) gives way to colon of normal or decreased caliber.

Barium enema examination may be negative in early, mild cases of Hirschsprung's disease. The earliest x-ray sign is an abnormal stasis of barium in the colon. Subsequently a disparity in caliber between the ganglionic and aganglionic segments of the colon may be expected to appear and to progress, depending on the duration and severity of the obstruction. Repeat examinations are suggested at intervals of a few months in children with a history of severe constipation dating from the neo-natal period, in whom results of the initial barium enema study are negative or doubtful.

To detect stasis or failure of adequate evacuation, post-evacuation films are recommended at twenty-four and forty-eight hours. This applies to patients in whom prompt elimination of the barium is not effected.

Seventeen roentgenograms; 1 table, summarizing observations in 16 cases.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

Volvulus of the Transverse Colon Occurring as a Postoperative Complication. Jerry Zaslow and Theodore Orloff. Am. J. Surg. **87**: 780–782, May 1954.

A case of volvulus of the transverse colon, a relatively rare occurrence, is presented. The patient was a 69-year-old white male who was operated upon for carcinoma of the sigmoid. An end-to-end anastomosis was done after resection of the bowel from the mid descending colon to the sigmoid. After an uneventful postoperative course, intermittent mid-abdominal cramps and mild nausea developed on the tenth day, with upper abdominal distention. A presumptive diagnosis of early intestinal obstruction was made and a Cantor tube was passed into the jejunum. Roentgenograms showed the tube in the upper jejunum, absence of gas in the small bowel, and a distended transverse colon, suggesting volvulus. Exploration revealed a redundant segment of bowel which had twisted 180 degrees on a long mesentery. The free edge of the omentum was densely adherent to the previous lower left rectus incision and acted as the fulcrum for the twisted bowel. The omentum was resected to prevent a recurrence of the torsion. By the tenth day following this procedure the x-ray appearance was normal.

Interestingly enough, volvulus is an infrequent cause of intestinal obstruction in this country and in England but is responsible for almost one-third of the cases of obstruction in the Scandinavian and Baltic countries. Factors concerned in the etiology include any of the following, alone or in combination: (1) elongation of the mesentery with a freely movable bowel, (2) absence of the mesentery with a mobile bowel, (3) closely approximated points of fixation, (4) adhesions from previous surgery or congenital bands. Symptoms include cramping abdominal pains and increasing abdominal distention. The distention at first involves only the affected bowel but, as the condition progresses, it becomes more diffuse. Subsequently nausea and vomiting appear. The diagnosis may be suspected on the basis of the symptoms and physical findings and is corroborated by roentgenologic examination. Early in the disease adequate roentgen study may show clear-cut evidence of volvulus in the form of localized distention of the affected loop of colon, with little or no distention of the proximal bowel. As the condition progresses, there is usually moderate to marked distention of the small intestine. The latter depends in great part upon the competency of the ileocecal valve.

Roentgen examination should be done with the patient recumbent and erect, or, if the latter is not possible, in the right and left decubitus positions. A retrograde barium enema examination may be necessary for confirmation of the diagnosis, for in this way one may determine the exact location and degree of the obstruction. It is important to realize that the barium enema may of itself reduce the volvulus, particularly if it is in the sigmoid area. At the same time there is a possibility of perforation, although this is unlikely if the study is carefully performed.

The surgical considerations are discussed.

Three roentgenograms.

A. J. NICHOLAS, M.D.
Shreveport, La.

Volvulus of the Cecum: Emphasis on Possible Predisposing Lesions of the Left Colon. Hugh E. Wilson, Gerard Desforges, Herbert G. Dunphy, and Alexander J. A. Campbell. Arch. Surg. **68**: 593–604, May 1954.

The closed loop character of volvulus of the cecum, predisposing to rapid distention and perforation, makes early diagnosis mandatory, if the mortality is to be reduced. Unfortunately, the condition is rarely recognized before operation or autopsy. This should not be so, as the diagnosis in acute cases is not a difficult one, particularly with the aid of x-rays, if the possibility is considered. Many patients give a past history of episodes of crampy abdominal pain, distention, and temporary obstipation relieved suddenly by the passage of large amounts of foul-smelling flatus and loose stools.

Previous abdominal surgery and a history of constipation are also extremely common.

The usual onset is with colicky abdominal pain which is progressive and often localizes in the right mid-abdomen. Fecal vomiting may not be manifest for two or three days and occurs as the volvulus produces small bowel obstruction at the terminal ileum. As strangulation ensues, the pain becomes constant. The abdomen is distended. A large tympanitic mass is apparent, usually located in the upper abdomen. Absence of palpable cecum in the right iliac fossa is to be expected.

The x-ray study is probably the greatest single aid in diagnosis. Flat and upright abdominal roentgenograms are quite typical. The following criteria necessary for diagnosis are quoted from McGraw *et al.* (Surgery **24**: 793, 1948. Abst. in Radiology **53**: 605, 1949): "1. Cecum greatly dilated and appears to lie in an ectopic position. 2. Loops of small bowel may be seen distended with gas and often lying to the right of the distended cecum. 3. The ileocecal valve may be demonstrated lying to the right of the distended cecum. It will give a distinct shadow in contrast to the gas in the cecum surrounding it and the gas in the small bowel within it. 4. The spiral distortion of the mucous membrane folds may sometimes be seen at the site of twisting, being visible because of contrast with gas in the bowel. 5. There is usually a considerable dilatation of the small bowel with fluid levels in the upright position, suggestive of small bowel obstruction. 6. Usually there is a single fluid level in the distended colon. (In volvulus of the sigmoid there is usually no distention of the small bowel and two fluid levels in the distended loop can be seen in most instances.)" Barium studies are not necessary, but may support the diagnosis. A barium swallow will show the stomach behind the distended loop when the cecum is in the upper abdomen, and a barium enema may show the twisted mucosal folds at the site of torsion in the ascending or transverse colon.

Eight cases are reported, 4 of which had coexisting left colon disease (3 carcinomas, 1 benign stricture) which the authors believe predisposed to the cecal volvulus. This would strongly suggest that in any case of volvulus of the cecum an obstructive process in the left colon should be suspected and the patient should be investigated with that possibility in mind after the acute problem has been remedied.

Six roentgenograms. ALFRED O. MILLER, M.D.
Louisville, Ky.

Multiple Primary Carcinomas of the Large Intestine. Roderick L. Tondreau. Am. J. Roentgenol. **71**: 794–806, May 1954.

Multiple primary malignant tumors of the colon are not rare and occur more frequently than would be expected on the basis of chance alone. Of 812 patients undergoing surgery for cancer of the colon in the hospital of the University of Pennsylvania in a twelve-year period, 24 (2.9 per cent) had multiple primary carcinomas. The average age of the patients in this small series was 63.3 years, slightly more than that of patients with a single lesion, but the literature in general indicates that the occurrence of multiple carcinomas is not closely linked with senescence, but rather to an individual predisposition. The distribution of simultaneous carcinomas roughly parallels that of single carcinomas, about 75 per cent appearing in the rectum and sigmoid. On the other hand, 50 per cent of the non-simultaneous multiple lesions are found in the cecum and ascending and transverse colon.

The author points out the importance of a complete colon examination even after a lesion has been discovered by proctoscope or by digital examination. The barium enema study should be supplemented by double contrast examination in all cases. If, for any reason, roentgen examination cannot be carried out before the operative procedure, it should certainly be performed postoperatively. Patients who have had a resection for carcinoma of the colon should be followed at semiannual intervals for the rest of their lives. Reappearance of symptoms is frequently due to a new growth rather than to a recurrence.

Ten roentgenograms; 2 photographs; 3 tables.
LAWRENCE A. DAVIS, M.D.
University of Louisville

Enteric Pneumatosis. F. J. C. Matthews. Brit. M. J. **1**: 851–852, April 10, 1954.

This is the report of a single case of enteric pneumatosis involving the sigmoid, transverse colon, and splenic flexure. The usual sites are the mesenteric border of the small intestine and the proximal half of the large bowel. The disease is characterized by the occurrence of thin-walled gas-containing cysts in the subserous and submucous layers of the intestine. The cysts are either sessile or pedunculated, may be as large as grapes, and occur in local groups with skip areas of normal bowel between. The underlying cause is probably gaseous dilatation of the lymphatic channels due to stagnation in tortuous or obstructed vessels.

Roentgenograms reveal polypoid filling defects in the barium-filled bowel. Sigmoidoscopy in the present case revealed bluish, translucent polypoid masses, with evidence of recent hemorrhage from the cysts.

Complications include intestinal obstruction, pneumoperitoneum, volvulus, or extrinsic pressure effects.

The treatment in the author's case was surgical excision of the affected areas by a hemicolectomy with end-to-end anastomosis.

One roentgenogram. PAUL MASSIK, M.D.
Quincy, Mass.

Pneumostratigraphy of the Pancreas. M. Giraud, P. Bret, and G. Gostaz. J. de radiol. et d'électrol. **35**: 379–387, 1954. (In French)

For pneumostratigraphy of the pancreas about 1,200 c.c. of oxygen is injected into the retroperitoneal space, following which the stomach is insufflated through a tube. The stomach is distended until air enters the duodenum. Transverse stratigrams (tomograms) are then taken and the pancreas is well outlined. Calcifications may be accurately located as being within the pancreas and pancreatic tumors are well outlined.

Fourteen roentgenograms; 20 drawings.
CHARLES M. NICE, JR., M.D.
University of Minnesota

Pancreatography by Opacification of the Excretory Ducts of the Pancreas. L. Leger, L. Gally, and N. Arvay. J. de radiol. et d'électrol. **35**: 442–446, 1954. (In French)

A procedure is described for opacification of the excretory ducts of the pancreas. Through a mid-line incision the free border of the second portion of the

duodenum is incised. A polyethylene tube, 1 to 2 mm. in diameter, is inserted into the duct of Wirsung, and 2 to 3 c.c. of 70 per cent Diodone is injected slowly. Following the injection, the tube is left in position while the exposure is made.

The normal duct of Wirsung is narrow and shows little branching. In acute pancreatitis there may be little change. In chronic pancreatitis the duct is dilated and acini may be outlined. In the presence of tumor of the ampulla, the duct is dilated and small branches are outlined. In carcinoma of the pancreas, the duct is irregular in outline and may be displaced.

Six roentgenograms.

CHARLES M. NICE, JR., M.D.
University of Minnesota

Cystogastrostomy for Pancreatic Cyst. Report of a Case. Timothy A. Lamphier, William Wickman, and N. Gillmor Long. Arch. Surg. **68**: 666–676, May 1954.

The usual presenting complaint of a patient with a pancreatic cyst is abdominal pain, localized in either the right or left hypochondrium or the epigastric area and in many cases referred to the back. The patient may complain also of such symptoms as anorexia, indigestion, eructation, nausea, and vomiting, all of which are usually related to the pressure of the cyst on either the stomach or the small and large bowel. When the cyst is associated with a chronic pancreatitis, signs and symptoms of pancreatic insufficiency may also occur.

Abdominal examination usually reveals a large mass located above the level of the umbilicus in either the right or the left hypochondrium, depending upon the location in the pancreas. It is relatively immobile and somewhat tense. The x-ray examination is one of the best diagnostic aids. A pancreatic cyst may be suggested by a slight opacity in the epigastric area or by an enlarged or widened duodenal loop or a filling defect of the stomach, duodenum, or transverse colon caused by an extrinsic mass Gastric pneumograms may be helpful. A barium enema study may be of aid in revealing further displacement of surrounding organs. Conditions to be differentiated are hydrops of the gallbladder, omental or mesenteric cyst, hydronephrosis, a retroperitoneal tumor, a tumor or cyst of the liver, cyst of the spleen, and aneurysm.

The authors' patient was a 43-year-old white woman seen in 1951 with epigastric pain of one year duration. She had a cholecystectomy in 1938 and had been under treatment for diabetes mellitus since 1941. Examination revealed a mass in the epigastrium, moderately soft but fixed, just to the left of the mid-line. An x-ray examination elsewhere had shown evidence of a pancreatic cyst. When the abdomen was opened, there presented in the wound a huge cystic mass protruding through the gastrohepatic omentum. Further exploration revealed that the mass was adherent to the undersurface of both lobes of the liver, the aorta, the body and the head of the pancreas, the common hepatic duct, and the transverse mesocolon. The cyst contained approximately 600 c.c. of a thick gray fluid in which floated large sections of friable grumous material. A cystogastrostomy was performed and after a rather stormy postoperative course the patient was discharged greatly improved.

It has been shown roentgenologically, at various time intervals following pancreatic cystogastrostomy, that abnormalities of the stomach at the site of the anastomosis fail to exist and that eventually the cystic cavity atrophies and disappears.

One roentgenogram; 4 drawings.

ALFRED O. MILLER, M.D.
Louisville, Ky.

Cholangiography in Surgery. Harold D. Caylor. Am. J. Surg. **87**: 516–519, April 1954.

The author urges the routine utilization of immediate cholangiography whenever possible in surgery of the gallbladder and the common duct and outlines his technic, step by step. Diodrast, 70 per cent, is his choice of a medium. He mentions the following pitfalls and errors of procedure: improper filling; allowing the catheter or T-tube to overlie the biliary tract; bubbles in the biliary tract; introduction of the tube or catheter too far into the duct or even into the duodenum; respiratory movements, which, however, can be controlled by the anesthetist; over-distention of the biliary tract with the medium, which can conceal stones and also cause spasm of the sphincter of Oddi.

One hundred ninety-eight cholecystectomies and 66 cholangiograms were surveyed for data for the present study. No analysis of this series is given but the author states that the results of immediate cholangiography have been so successful that it has become a routine.

Three roentgenograms; 4 diagrams.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Residual Choledochal Stones. Etiology and Complications in One Hundred Ten Cases. N. Frederick Hicken, A. James McAllister, and Dee W. Call. Arch. Surg. **68**: 643–656, May 1954.

Five hundred and fifty patients from 11 hospitals who had drainage tubes placed in the gallbladder, cystic duct or common duct were examined by postoperative cholangiography and 110 were found in whom intraductal calculi were still present. A study of these cases was made with special attention to two questions: (1) Why were these stones missed at the primary operation, and (2) what clinical course did these patients with residual stones follow?

The original operations on the 110 patients were performed by 26 different surgeons, the majority of whom were occasional operators, while the others were well trained. The incidence of residual choledochal stones was 10 times as great in the 25 per cent of patients who had cholecystectomies performed by inexperienced surgeons as in the 75 per cent of patients operated upon by specialists. The failures of the inexperienced operators were attributable to (1) unfamiliarity with the abnormal ductal and vascular patterns, (2) inability to cope with hemorrhage, (3) failure to interpret properly the need for ductal explorations, and (4) inexperience with choledochal instrumentation. Certain pathologic conditions prevented complete operations during the primary approach, such as acute cholecystitis, fulminating pancreatitis, intrahepatic stones, and poor general condition of the patient. Even the experienced surgeons were compelled to adopt conservative procedures when confronted with these difficulties.

This study demonstrates that the postoperative clinical course affords no index as to the completeness of the primary operation. Only 13 per cent of the patients required a second laparotomy during the initial hospitalization, while 87 per cent were discharged as cured.

In only 21 per cent of the patients did jaundice subsequently develop even though some of them were followed for ten years or longer. Nevertheless, 81 per cent of the 110 patients eventually required secondary operations; in 7, plastic operations were necessary to improve the flow of bile.

Operative cholangiography is useful in demonstrating ductal abnormalities, in localizing the site and nature of ductal obstructions, in determining the patency of the ducts, and thus furnishing a guide as to the need for ductal explorations. Postoperative cholangiography provides information concerning the completeness of the primary operation.

Ten roentgenograms; 1 drawing; 2 tables.

ALFRED O. MILLER, M.D.
Louisville, Ky.

THE DIAPHRAGM; HERNIA

Diaphragmatic Pneumocele Complicating Therapeutic Pneumoperitoneum. A Review and Report of Four Cases. Robert L. Guillaudeu and Donald B. Stewart. Am. Rev. Tuberc. **69**: 745–758, May 1954.

An air-filled sac arising from the diaphragm is designated as a diaphragmatic pneumocele. The pneumocele may be seen as an annular shadow on the chest film of an asymptomatic person with therapeutic pneumoperitoneum or may rupture and produce the marked symptoms associated with tension pneumothorax. The lesion may be visible for the first time when the pneumothorax results in separation of the lung and diaphragm. In other instances, the first roentgenographic finding is a thin-walled area of radiolucency projecting below the dome of the diaphragm in the frontal view and noted to lie posteriorly and extend upward into the thorax in the lateral view. All of the reported lesions have been on the right side. The presence of a pneumocele is believed to be a contraindication to continuing pneumoperitoneum therapy, since perforation with resultant tension pneumothorax is a frequent occurrence.

The authors feel that the changes in position of the liver in therapeutic pneumothorax are responsible for the weakness in the right diaphragm which results in its rupture or in the formation of a pneumocele. The liver is separated from the diaphragm, rests on the abdominal viscera, and is supported by the triangular and coronary ligaments and by the attachments through the hepatic vein to the inferior vena cava. Slight rotation toward the mid-line results in increased tensions upon the diaphragm in abnormal directions. This may separate some fibers of the diaphragm at the posterior and lateral attachment of the triangular ligament and the defect thus formed is enlarged because of the pressure difference between the abdominal and thoracic cavities resulting from the pneumoperitoneum. Histologic examination in two cases reported in the literature showed fibrous and areolar tissue with granulation tissue on both surfaces of the pneumocele in one case and connective tissue and muscle fibers in the other.

Four cases are reported; in 3 the sac ruptured, resulting in tension pneumothorax. In the other, the pneumoperitoneum was discontinued when the pneumocele was recognized on a chest roentgenogram.

Nine roentgenograms; 1 drawing; 1 diagram.

JOHN H. JUHL, M.D.
Minneapolis, Minn.

Hernia through Foramen of Winslow. Report of a Case with Preoperative Roentgen Diagnosis and Successful Surgical Management. Alan L. Dorian and George N. Stein. Surgery **35**: 795–801, May 1954.

The authors present a case of hernia through the foramen of Winslow in which diagnosis was suggested preoperatively. This would appear to be the seventh such case in the literature.

A 54-year-old white woman entered the hospital complaining of epigastric fullness, pain in the right upper quadrant, and intermittent vomiting. Supine and upright studies of the abdomen showed an unusual radiolucent shadow, with an air-fluid level, medial to the stomach. A subsequent upper gastrointestinal series showed the hepatic flexure, ascending colon, and cecum to be herniated into the lesser sac. These structures were medial and posterior to the stomach. A barium enema study (to see how much of the transverse colon was involved) disclosed almost complete obstruction in the proximal transverse colon. The hernia was surgically reduced.

The authors conclude that all roentgen signs of herniation through the foramen of Winslow are concerned with the demonstration of air in the lesser sac.

Five roentgenograms; 4 drawings; 2 photographs.

RICHARD E. OTTOMAN, M.D.
University of California

Diaphragmatic Hernia Simulating Hydropneumothorax. C. L. Boice. California Med. **80**: 405–406, May 1954.

The author reports a diaphragmatic hernia in which a grossly dilated, obstructed stomach filled the left hemithorax, simulating a hydropneumothorax to such a degree that a thoracentesis was done before the correct diagnosis was established. It is believed that the erroneous interpretation could have been obviated by further investigation of the previous clinical history and by x-ray study of the abdomen at the time the films of the chest were studied.

Seven roentgenograms.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

THE MUSCULOSKELETAL SYSTEM

A Review of the Radiographic Features of Some General Affections of the Skeleton. W. S. Shearer. Edinburgh M. J. **61**: 101–110, April 1954.

In this paper, which was given as the Honyman Gillespie Lecture in 1952, the author discusses in some detail a few examples of generalized affections of the skeleton. In each instance he describes the roentgenographic appearance and indicates how a diagnosis was reached. In conclusion he offers the following suggestions for studying roentgenograms in such cases:

"If a bone lesion as seen radiographically does not show reactive change in the adjacent bone or periosteum which suggests an inflammatory process or the invasive character of a neoplastic process, you should then have in mind the possibility of a dysplasia. Study then the localisation; is it involving primarily metaphyseal bone or does it involve only the epiphyses or only the small bones? Study then the nature of the abnormal process. Is it merely an arrest of growth, does the appearance suggest a cartilage dysplasia or a fibrous dysplasia? Then proceed to carry out a survey of the skeleton to show the distribution of the abnormal

bone. Do not forget to note whether the condition is associated with a generalised osteoporosis or whether bone apart from the involved area is normal. Then consider the findings in relation to the full history and clinical examination as well as biochemical blood analysis. Having done this, I think you will at least make an intelligent approach to the correct diagnosis, and will usually reach a satisfactory conclusion."

Twenty-four roentgenograms.

The Natural History of Osteoid Osteoma, with a Report of Twenty Cases. J. S. R. Golding. J. Bone & Joint Surg. **36-B**: 218–229, May 1954.

Osteoid osteoma is most frequently seen in the second decade of life and more frequently in males. Pain is the characteristic clinical finding. It is severe, poorly localized, and usually worse at night.

Radiographically, the characteristic appearance is that of a zone of reactive bone sclerosis about a small central radiolucent nidus. Within the central radiolucent area occasional irregular calcification may be seen. The reactive sclerosis is greatest when the lesion is in or near compact bone. In cancellous bone, the reaction may be minor roentgenologically, and occasionally may be identified only when the opposite normal side is studied.

Osteoid osteoma is most commonly seen in the tibia, femur, bones of the foot, vertebrae, and bones of the hand, in that order of frequency. Histologically, the lesion is a well circumscribed mass of osteoid tissue within a highly vascular connective-tissue stroma.

The differential diagnosis concerns mainly inflammatory processes, such as a Brodie's abscess or Garré's type of sclerosing osteomyelitis.

The treatment of choice is complete excision.

Six roentgenograms; 1 photograph; 2 photomicrographs.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

Contribution to the Pathological Picture of Osteomyelosclerosis. H. Braun and H. Kleinfelder. Fortschr. a. d. Geb. d. Röntgenstrahlen **80**: 612–617, May 1954. (In German)

The condition designated as osteomyelosclerosis is recognized by splenic enlargement, fibrous and sclerotic changes in the bone marrow, and a myeloid type of blood change, with erythroblasts, myelocytes, myeloblasts, and an occasional megalocyte. The alkaline phosphatase is elevated during the active stages of the disease.

X-ray studies show lack of spongy structure and rather homogeneous sclerotic changes in the spine. These are demonstrated to best advantage on the lateral view. The pelvis also shows relatively homogeneous sclerosis, bilaterally, especially about the sacroiliacs, and frequently more irregular sclerotic changes within the iliac bone. Similar changes are noted in the femoral epiphyses. Irregular osteolysis may be present in the lesser trochanters.

Differential diagnosis from leukemia is usually not difficult in spite of the fact that sclerotic changes may be present in the latter disease. Findings on sternal puncture are characteristic, and recognition of reticular and giant cells help in differentiation. The blood and bone changes do not parallel each other. The earliest roentgen changes are often observed in the spongiosa, with thickening and increased bone deposit in the trabeculae. Associated periosteal thickening is occasionally seen in the early stage. A diffuse homogeneous sclerosis may closely simulate Albers-Schönberg disease. In other instances, there is a mottled appearance strongly resembling metastatic involvement.

The authors' case showed a number of rather unusual findings: (*a*) Osteosclerosis was limited to the borders of the sacroiliac joints. In the average case the greatest bone condensation is in the floor of the acetabulum. (*b*) There was less reaction than average in the spongy bone. (*c*) The sclerotic reaction was limited to the femoral epiphyseal region, without involvement in the neck of the bone. (*d*) There was pure osteolysis in the lesser trochanter. To the authors' knowledge, these peculiarities have not been previously observed.

Two roentgenograms; 1 photomicrograph; 2 drawings.

E. W. SPACKMAN, M.D.
Fort Worth, Texas

Albers-Schönberg Disease, with Report of Two Cases in an Egyptian Family. M. A. Abboud, Z. H. Abdin, and O. Alfy. Arch. Pediat. **71**: 131–138, May 1954.

Two cases of Albers-Schönberg disease in an Egyptian family are reported. The first patient, an 8-year-old girl, was admitted to the hospital with a pulmonary complaint. She was dwarfed but had no roentgen evidence of abnormality of the pituitary fossa. The second patient, a brother of the first, showed little if any dwarfism but marked abnormality of the pituitary fossa. Roentgen examination in both cases revealed marked sclerosis of all the bones of the body, especially the femora, tibiae, spine, pelvis, radii and ulnae.

The authors were unable to find any mention of other cases of Albers-Schönberg disease in Egypt, either in adults or children.

Six roentgenograms; 2 photographs.

A Case of Osteopathia Striata. D. U. Bloor. J. Bone & Joint Surg. **36-B**: 261–265, May 1954.

The author reviews a case of osteopathia striata in a 3-year-old girl. The child was first seen because of nasal obstruction and recurring bronchitis. There was a history of both mental and physical retardation, with some improvement during a six months course of thyroid.

Roentgenologically there was a fine striation of the long bones, more marked at the ends. In general, the striations were linear, vertical, and regular. In the ilia, however, they presented a fan-like appearance. The large skull showed increased density at the base and in the frontal bone. No condensations or dense spots were seen. The ribs, clavicles, and vertebrae were normal. Other members of the family had normal appearing osseous structures.

The author quotes a personal communication from Fairbank to the effect that, except for osteopathia striata, this striated appearance of bones occurs only in occasional cases of celiac disease.

Six roentgenograms.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

Vitamin A Poisoning in Adults, with Description of a Case. Alexander Gerber, Adolph P. Raab, and Albert E. Sobel. Am. J. Med. **16**: 729–745, May 1954.

A case of chronic hypervitaminosis A in a 28-year-old white female is presented. Over a period of eight and a half years she was hospitalized ten times because of

complaints referable to vitamin A intoxication. Many diagnoses had been made, including brain tumor, serous meningitis, chronic encephalitis, viral radiculo-encephalitis, psychoneurosis, and generalized infectious arthritis. The bizarre clinical picture led to additional investigations to exclude Addison's disease, dermatomyositis, and hepatitis. In an effort to provide symptomatic relief, many measures had been undertaken. These included a subtemporal decompression for the relief of increased intracranial pressure, the application of body spicas, fever therapy, radiotherapy, and physiotherapy. During the entire period the patient was allowed to continue the daily consumption of 500,000 units of vitamin A because of the supposed beneficial effects on "ichthyosis" of the skin. When the clinical diagnosis of hypervitaminosis A was finally suggested, a fasting vitamin A blood level of 2,000 μg. per 100 c.c., the highest ever recorded, was obtained.

Changes demonstrable on x-ray examination were present in the dorsal and lumbar spine, pelvis, femora, patellae, tibiae, calcanea, scapulae, and skull. The fundamental disorder consisted of calcification, with or without true bone formation, of the pericapsular, ligamentous, tendinous, and subperiosteal structures. The pain and progressive crippling deformities had been previously considered the result of generalized infectious arthritis. The differences between Marie-Strümpell arthritis and vitamin A intoxication are discussed in detail.

Clinical improvement in the neurologic, skeletal, and skin manifestations took place rapidly upon discontinuance of excess vitamin A intake.

Four roentgenograms; 2 photographs; 2 photomicrographs; 1 graph; 1 table.

Cushing's Syndrome. Basil Strickland. Proc. Roy. Soc. Med. **47**: 341–345, May 1954.

The two main features of Cushing's syndrome, radiographically, are osteoporosis and fractures. Five cases are reported in which fractures were the predominant feature, without an associated osteoporosis in 2 patients. The sites of fracture were the pubic bones, ribs, vertebrae, and femur, with multiple involvement in all cases. In 2 patients fractures were recognized before the clinical diagnosis of Cushing's syndrome was made. The fractures heal well with abundant calcified callus. The signs and symptoms of Cushing's disease may be simulated by overdosage of ACTH or cortisone, but fractures in such cases are uncommon and heal poorly.

Summarizing the indications for radiography in Cushing's syndrome, the author concludes: "In Cushing's syndrome then the radiologist will survey the whole skeleton for fractures and osteoporosis, he should be diligent in his search for the former and critical in his assessment of the latter. He will expect the heart to be enlarged and the pituitary fossa to be normal, and he will carry out presacral pneumography, pyelography and possibly tomography in an attempt to demonstrate an adrenal tumour."

Seven roentgenograms. PAUL MASSIK, M.D.
Quincy, Mass.

Hyperparathyroidism with Increased Bone Density in the Areas of Growth. A. Adam and D. Ritchie. J. Bone & Joint Surg. **36-B**: 257–260, May 1954.

The authors report a case of primary hyperparathyroidism in a child in association with bands of increased bone density in growth areas. They believe that the latter finding may be a usual accompaniment of primary hyperthyroidism in childhood, though only one other case appears to have been reported (presented by Aub in 1942 before the Association for the Study of Internal Secretions).

The patient was a girl of 14 years with classical signs and symptoms of hyperparathyroidism secondary to a small parathyroid adenoma. Three weeks before admission she sustained a pathological fracture through a large multilocular cyst expanding the proximal tibial shaft. Roentgenograms revealed generalized osteoporosis. The long bones exhibited widespread cyst formation. In the juxta-epiphyseal segment of all long bones there was a true increase in bone density (as compared to a control of the same age and sex). These amorphous appearing bands showed little bone detail. The greatest degree of density occurred in the areas of most active bone growth. The density was absent in the elbow, where the epiphysis had already fused.

Convalescence after removal of the adenoma was uneventful. Periodic roentgenograms showed a decrease in bone density, with the wrists having completely returned to normal at the time of the report.

Seven roentgenograms.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

Congenital Syphilis Diagnosed by Bone Changes. K. L. Marks. Brit. M. J. **1**: 1018, May 1, 1954.

It is quite a tribute to public health workers and to penicillin that a single case of congenital syphilis is considered worth reporting. In the author's patient, a two-month-old infant, the diagnosis was made by the radiologist's finding of the typical syphilitic osteochondritis (in all four limbs). There were irregular areas of destruction, submetaphyseal osteoporosis, thickened bands of temporary calcification, and beginning periosteal calcification.

Three roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Bone Changes in Diabetes. William A. Copland. Proc. Roy. Soc. Med. **46**: 345–347, May 1954.

This paper is concerned mainly with the roentgen changes to be seen in the metatarsals and phalanges in diabetics. Fifty elderly patients with diabetic neuritis, gangrene, absence of pulses, corns, and ulcers on the feet were examined radiographically. In addition, 13 cases of diabetes with changes in the bones of the feet, from another hospital, were reviewed. In all an inflammatory lesion was present or had been present near the involved bone, the commonest being a perforating ulcer.

The author attributes the bony changes in diabetes to an inflammatory invasion. The earliest evidence of bone involvement is osteoporosis, which is followed by a break in the cortex and then by osteitis. This may heal, with periosteal new bone formation. More frequently, however, the head of the bone is gradually destroyed and the shaft is then attacked, with progressive destruction of the medulla, giving a taper or pencil ["sucked candy"] appearance. The process may stop at any stage.

These destructive changes may be observed in non-diabetics as well. Another interesting bone change occurring in the feet of both diabetics and non-diabetics is subperiosteal new bone formation along the shafts of the outer metatarsals in cases with a lesion on the medial

side of the foot. It is thought to be associated with abnormal weight-bearing.

Nine roentgenograms; 1 diagram.

PAUL MASSIK, M.D.
Quincy, Mass.

Nuclear Herniations of the Intervertebral Disc. Their Radiological Manifestations and Significance. A. C. Begg. J. Bone & Joint Surg. **36-B**: 180–193, May 1954.

The nucleus pulposus may herniate through the annulus fibrosus circumferentially and the cartilage plates above and below. Radiology offers the best and occasionally the only means of studying the variable types of herniation during life.

Herniations of the nucleus pulposus into the spongiosa of the vertebral body occur most frequently in the thoracic and lumbar spine. The extrusions, or Schmorl's nodes, are not identified radiologically until a thin layer of compact bone has been laid down around them. They are variable in size. These changes are common in later life as a result of degenerative changes. When they occur in adolescence, they are probably caused by a congenital weakness of the cartilage plate at the site of the notochordal canal or by scarring of degenerated blood vessels which supply the juvenile disk. With loss of the nucleus, pressure becomes unevenly distributed anteriorly over the developing epiphyseal ring and retards development, with resultant anterior wedging of the vertebral body. This leads to adolescent kyphosis or Scheuermann's disease.

With herniation of the nucleus through the anterior part of the annulus, there is impingement upon the tough anterior longitudinal ligament, which usually deflects it to produce an erosion of the anterior border of the vertebral body. Such herniations may be a cause of back pain and should be differentiated from inflammatory disease, particularly tuberculosis. This anterior herniation is best seen in cases of chondrodystrophy, where the characteristic anterior erosion occurs.

The anterior portion of the annulus is firmly attached to the edge of the vertebral body and anterior longitudinal ligament. With herniation of the nucleus beneath the epiphyseal ring, a crescentic fragment of the body fractures off, presenting as a "persistent epiphysis."

When the nucleus is displaced laterally, characteristic osteophytes are produced secondary to the abnormal periosteal stimulation.

Posterior herniation is well recognized. Radiological signs aiding in locating the level of the lesion on the plain radiograph are: narrowing of the disk space, hypertrophic or sclerotic changes of the opposing vertebral bodies, localized scoliosis, relative displacement of the vertebral body, and the "vacuum phenomenon."

Myelography offers additional information as to the type and location of herniation in spines appearing normal on plain radiography or in those with diffuse degenerative changes.

Thirty-six figures, including 28 roentgenograms.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

Structural Changes in the Lumbar Intervertebral Discs. Their Relationship to Low Back Pain and Sciatica. R. I. Harris and Ian Macnab. J. Bone & Joint Surg. **36-B**: 304–322, May 1954.

Damage sustained by one part of the spine is frequently reflected by injuries in other parts. Thus, acceleration of the normal aging process, or disk degeneration, may be accompanied by changes other than simple extrusion of the nuclear material and its impingement on the nerve root. The authors studied 123 lumbar spines excised at routine necropsies in an attempt to obtain information on the anatomical, physiological, and pathological variations that may occur. After a preliminary radiograph of the cadaver and of the excised spine, a careful dissection was carried out. Special attention was given to correlation of the changes thus observed, the radiographic findings, and the clinical picture.

The vertebral bodies commonly undergo lipping or osteophyte formation.

The posterior joints at levels of degenerating disks become somewhat unstable, tend to undergo subluxation, predisposing to fractures of the articular facets. As the joints override, the tip of the inferior articular facet may impinge on the subjacent lamina, producing a bony reaction, and may eventually partially erode the lamina.

Early roentgenologic evidence of disk degeneration can be obtained by radiographing the spine in full extension and full flexion. At the level of degeneration excessive flexion occurs together with some anteroposterior shift. These changes may be seen before significant narrowing of the disk space occurs. On the lateral view retrospondylolisthesis and pseudospondylolisthesis with associated disk degeneration may be seen. These findings indicate posterior joint damage because of facet overriding and suggest the possibility of nerve root compression. Oblique projections will reveal malalignment of the articular surface and impingement of the subluxated facets on the adjacent laminae. With long-standing disk degeneration, arthritic changes in these joints may be recognized in both the anteroposterior and oblique views.

Eleven roentgenograms; 4 photomicrographs; 22 photographs; 1 drawing.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

Herniation of Thoracic Intervertebral Discs with Spinal Cord Compression in Kyphosis Dorsalis Juvenilis (Scheuermann's Disease). Case Report. John H. Van Landingham. J. Neurosurg. **11**: 327–329, May 1954.

Posterior herniations of intervertebral disks are less common in the thoracic region than in the lumbar or cervical regions. Such herniations are apt to produce evidence of cord compression rather than root compression or localized back pain. They tend to occur after the age of thirty.

In the case reported here myelography was performed on a 17-year-old boy with a dorsal kyphotic deformity and roentgen signs of kyphosis dorsalis juvenilis (Scheuermann's disease). Myelograms showed ventral filling defects at the level of the seventh, eighth, and ninth thoracic interspaces. Laminectomy confirmed the findings and extradural removal of the ruptured disks resulted in relief of symptoms.

The unusual features of the case are its occurrence at so early an age and the coexistence of Scheuermann's disease.

One roentgenogram; 1 drawing.

JOHN F. RIESSER, M.D.
Springfield, Ohio

A Radicular Syndrome from Developmental Narrowing of the Lumbar Vertebral Canal. H. Verbiest. J. Bone & Joint Surg. **36-B:** 230–237, May 1954.

The author reports 7 proved cases, illustrative of a new radicular syndrome based upon developmental narrowing of the lumbar vertebral canal. All patients were men between the ages of thirty-seven and sixty-seven.

The clinical picture appears quite characteristic. In the upright position, whether walking or standing, the patients present signs of disturbance of the cauda equina: bilateral radicular pain, disturbances of sensation and impairment of motor power in the legs. In the recumbent position, the symptoms immediately disappear, and the neurological examination is negative. The muscle discomfort in the legs may be mistakenly attributed to intermittent claudication of vascular origin.

Routine roentgenograms showed no abnormality of the lumbar spine. Myelography, however, disclosed a complete block in all cases, the appearance suggesting extradural compression. The obstruction was due to narrowing of the lumbar vertebral canal in its anteroposterior diameter or to a constriction of the canal behind the pedicles as a result of enlargement of the medial part of the articular facets.

Surgical decompression of the narrowed lumbar vertebral canal relieves the symptoms.

Eight roentgenograms.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

Frontal Plane Fissures in the Vertebral Bodies. W. Swoboda. Fortschr. a. d. Geb. d. Röntgenstrahlen **80:** 603–607, May 1954. (In German)

Two examples of a rather rare anomaly of ossification are described, consisting of a frontal plane defect in the vertebral body visualized to best advantage on lateral films. Lossen (Anat. Anz. **73:** 168, 1931) demonstrated this defect in a 30-cm. fetus, involving a lumbar vertebral body. He considered it to represent the residue of the chorda dorsalis. Later investigators showed it to be a transverse fissure defect with an enchondral ossification zone dividing the body roughly into two portions of approximately equal size.

The defect usually disappears at about the fourth postnatal month but may persist. The author attributes it to incomplete union or non-union of the primitive osseous nuclei. An anomalous condition of the vessels has also been noted, an anterior and a posterior arterial branch entering the body of the vertebra.

The relative frequency of this anomaly in the fetus and its rarity after birth indicate that it is a variation of ossification or an "inhibition abnormality," rather than a true developmental anomaly. Most of the reported cases have occurred in babies which were somewhat underweight at birth, and the condition was observed in both the dorsal and lumbar vertebral bodies.

Two roentgenograms; 1 drawing.

E. W. SPACKMAN, M.D.
Fort Worth, Texas

Epiphyseal Necrosis of the Spinous Process of One of the Lumbar Vertebrae. A. Ravelli. Radiol. clin. **23:** 162–166, May 1954. (In German)

A 27-year-old woman complained of constantly recurring pain in the back for two years. X-ray examination of the lumbar spine showed, on the underside of the tip of the spinous process of the fourth vertebral body, a smooth trough-like defect containing two separate areas of bony density. The floor of the trough presented a dense sclerosis, as did the edges of the two bony fragments facing it.

As far as the author could find, only 4 similar cases have been described. These were in boys of fourteen to sixteen years of age, who complained of pain in the region of the first thoracic spinous process after unusual exertion. There was some localized tenderness and slight edema over this process. All 4 boys presented a similar radiographic picture: some three to five weeks after the beginning of their ailment the spinous process showed an approximately concave, irregularly delimited terminal defect, so that the process was clearly shorter than its neighbors. After several months, the defect gradually filled in with bone. At the same time, one or several small isolated bony shadows appeared either in the vicinity of the defect or some distance from it. These small islands—or secondary epiphyses—then became larger and fused with each other and with the spinous process. After the synostosis was complete, the internal structure of the vertebra was normal but the shape was somewhat changed.

This disease is to be considered an aseptic necrosis of bone comparable to Osgood-Schlatter's disease. According to the custom of naming the aseptic necroses after their discoverers, the author suggests that necrosis at the apex of the spinous process of the first thoracic vertebra be referred to as Schmitt's disease, since it was Schmitt who described the first 4 cases, referred to above (see Schmitt and Wisser: Arch. f. klin. Chir. **268:** 333, 1951).

Although there is a difference in Schmitt's cases and the one herein described, in that the site of the disease and the ages of the patients differ, it is believed that the fundamental process of aseptic necrosis is the same. The disturbance of ossification must have occurred in the early phase of development of the epiphysis at the beginning of puberty. That this abnormal appearance does not represent simply an anatomic defect, but a mechanical-functional one, is indicated by the sclerosis both on the floor of the defect and on the sides of both epiphyseal fragments facing the defect.

Two roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Tabetic Charcot's Spine. Report of Eight Cases. Douglas J. Campbell and J. Oliver Doyle. Brit. M. J. **1:** 1018–1020, May 1, 1954.

Charcot spine shows the same disorganization, with combined destruction, proliferation, and eburnation, as do peripheral Charcot joints, with the added feature of abnormal curvatures in either plane. Other clinical evidence of syphilis is usually abundant by the time the condition is suspected.

Eight cases are reported in some detail, with a single anteroposterior roentgenogram. As is usually the case, the pronounced x-ray findings were out of all proportion to the local symptoms.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

The Anatomy of Hallux Valgus. R. Wheeler Haines and A. McDougall. J. Bone & Joint Surg. **36-B:** 272–293, May 1954.

In hallux valgus, the early and essential changes are

stretching of the medial ligaments of the metatarsophalangeal joint which attach the medial sesamoid and the proximal phalanx to the metatarsal, and erosion of the ridge that separates the grooves for the sesamoid on the metatarsal head. As the hallux valgus develops, the medial eminence squares off, due to osteophytic lipping, and in chronic cases degenerates or disappears.

Roentgenographically, the early case of hallux valgus is seen as some deviation of the first metatarsal, insufficient, however, to displace the second toe. The bones appear normal structurally except for a slight increase in density of the medial side of the first metatarsal, a bony outgrowth from the base of the terminal phalanx, and an irregularity of ossification in the medial sesamoid. The proximal phalanx is displaced laterally to a slight degree. The sesamoids still lie in their respective grooves.

As the process becomes more severe, the base of the proximal phalanx is displaced further in a lateral direction and there is pronation on the head of the metatarsal. The internal structure becomes less dense. The sesamoids are displaced laterally and become larger.

In more severe cases, osteophytes appear on the edge of the medial eminence, giving this a square appearance. Eventually the medial eminence may be destroyed and the sesamoids become displaced even more lateralward.

Fifty-three figures, including 23 roentgenograms.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

GYNECOLOGY AND OBSTETRICS

The Artificial Menopause, with Particular Reference to the Occurrence of Spinal Porosis. Ian A. Donaldson and J. R. Nassim. Brit. M. J. **1**: 1228–1230, May 29, 1954.

The authors have made a study of osteoporosis in 94 women in whom an artificial menopause had been induced at least eighteen months earlier: in 82 of these, both ovaries had been removed surgically, and in 12 radium had been used. Roentgenograms of the spine were available for 79 of the patients who had undergone surgery, and evidence of osteoporosis was found in 10. Roentgenograms of the 12 women who received radiation were similarly evaluated, and 2 were found to have osteoporosis. In none of the 12 was this considered to be of greater severity than Grade I. In view of these observations, the incidence of osteoporosis in women subjected to an artificial menopause, whether by surgery or irradiation, is considered to be within the physiological range. No significant abnormality in serum phosphate levels was observed.

Hypertension was encountered in 28 of the 94 women. An hereditary factor was found to be operative in most of the patients. There was no evidence that the hypertension was attributable to the menopause.

The majority of the women experienced a gain in weight following induction of the menopause. In 26.5 per cent the weight remained the same or decreased. Hot flashes occurred in approximately 75 per cent, and there was no significant difference in this respect between those who had had a surgical menopause and those who had had a radium menopause. Libido was decreased in approximately 65 per cent, but the fact that libido was unaffected in some indicates that it is not dependent upon the ovary for its maintenance. The authors agree with Bland-Sutton and Giles (The Diseases of Women, London, Heinemann, 1926) that the only two constant effects of removal of the ovaries are amenorrhea and sterility.

A similar clinical, chemical, and radiologic study was made of 28 women who came to the hospital with the specific complaint of pain in the back. Nine of the 28 had had some form of pelvic surgery, with removal of one or both ovaries; the others were considered to have had a natural menopause. Among this second group of women, 18 were found to have osteoporosis of Grade III and 10 of Grade II.

The authors classify osteoporosis as follows: Grade I, a marked stencilling of the vertebral bodies with coarsening of bone trabeculation; Grade II, same characteristics as Grade I, plus swelling of the intervertebral disks, which gives rise to biconcavity and the so-called codfish vertebrae; Grade III, characteristics of Grade II, plus crush fractures.

A very slight increase in serum phosphate levels (to an average of 3.6 mg. per 100 ml.) was encountered in the second group of women. No relationship was found among the time of onset or the severity of complaint of backache, the age at which the menopause, either natural or artificial, occurred, and the number or frequency of pregnancies.

[This report suffers from a slight confusion between natural and artificial menopause. Among the 94 women who are classified as having an "artificial" menopause were 56 in the fifth decade, 28 in the sixth decade, and others up to the age of 73 years, at the time of operation.—A.S.T.]

Three tables.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Investigation of the Tissue Reaction in Hysterosalpingography with Water-Soluble Contrast Material. K. Fochem and R. Ulm. Fortschr. a. d. Geb. d. Röntgenstrahlen **80**: 635–638, May 1954. (In German)

With the use of oily media for hysterosalpingography, a residue may remain for weeks or months after injection, leading in some instances to an inflammatory reaction, especially in the tubal mucosa, with formation of granulation tissue. Water-soluble media have been found to produce no such reaction or other untoward effect, even when the lymphatic channels have been filled. The authors report 3 such cases, in which the medium used was Joduron S (Cilag). They also describe preliminary experiments on rats.

The contrast substance was injected into the peritoneal cavity and the abdominal wall of the experimental animals, and these were killed and examined at various intervals up to ninety-six hours. A moderate amount of colorless fluid remained in the peritoneal cavity as long as eight hours (maximum between two and four hours), but no opaque material was present after thirty minutes. Exhaustive histologic studies showed no pathologic changes.

The authors point out that for water-soluble media a stable iodine preparation is essential. They also warn that with such media, the usual possible complications of hysterosalpingography may still be present. Filling of the lymphatic channels is usually incident to some form of abrasion or lesion of the uterine mucosa.

Three roentgenograms.

E. W. SPACKMAN, M.D.
Fort Worth, Texas

Radiological Estimation of Pelvic Expansion. Arthur Weinberg. J.A.M.A. **154**: 822–823, March 6, 1954.

The question of whether the true bony pelvis under-

goes significant expansion before or during labor was studied by reviewing the pelvic measurements of 171 patients in whom x-ray pelvimetry was done by the same technic ten days before term in two or more pregnancies.

Inlet studies on 150 women at the end of their first and second pregnancies showed the average increase in the transverse diameter of the inlet to be 3.4 mm. In 43 women the average increase between the end of the second and third pregnancy was 2.5 mm. A change of 5 mm. or more was thought to be significant; 34 per cent of the first group and 21 per cent of the second group showed this degree of expansion. No consistent or significant change was noted in the true conjugate.

In the midpelvis, the average increase in the interspinous diameter at the end of the second pregnancy in 144 cases was 3.7 mm. The average increase between the second and third delivery was 2.8 mm. Of 23 patients studied near term in three consecutive pregnancies, 52 per cent showed a greater increase between the first and second pregnancy, and 26 per cent between the second and third, 4 per cent showing equal change, and 18 per cent no change. No significant change in the anteroposterior diameter of the midpelvis was found.

Symphyseal spread amounting to five to six times the prepregnant separation occurred in 4 of the 171 patients, with associated increase in the transverse diameter of the inlet of 6 to 9 per cent and in the interspinous diameter of 3 to 8 per cent.

The author believes that significant pelvic expansion occurs in about one-third of all pregnancies and that it is permanent except when accompanied by pathologic symphyseal spread. Since the conditions under which expansion occurs are inconstant, a trial of labor is recommended if the dimensions are within 5 to 10 per cent of the eutocia levels at the inlet and midpelvis in both primiparas and multiparas.

WALTER M. WHITEHOUSE, M.D.
University of Michigan

The Contracted Outlet. D. Frank Kaltreider. J.A.M.A. **154:** 824–827, March 6, 1954.

Outlet measurements, obtained clinically and radiologically, were reviewed in 1,866 vertex deliveries in which labor proceeded to full dilatation of the cervix and terminated spontaneously, by low forceps, or by cesarean section with infants weighing between 2,500 and 4,000 gm. Difficult deliveries are defined as (1) those in which excessive traction was needed for vaginal delivery; (2) those in which difficulty in rotation was encountered; (3) those in which cesarean section was done after full dilatation of the cervix because of lack of progress in the second stage with good contractions; (4) those in which the infant showed evidence of intracranial hemorrhage.

Plotting of the sum of the clinical intertuberous and posterior sagittal diameters at 0.5-cm. intervals against percentage of difficult deliveries gave discontinuous variations. Comparison of clinical and x-ray intertuberous measurements with soft-tissue correction of 2 cm. showed the clinical measurements to be accurate in only slightly over 20 per cent.

Plotting of the sum of the intertuberous and posterior sagittal diameters as determined by x-ray against the percentage of difficult labors gave a smoother curve, suggesting that if the measurements were sufficiently accurate, the sum might be a prognostic yardstick. Such accuracy, however, has not been achieved.

Plotting of the anteroposterior diameter of the outlet in relation to difficult delivery gave a much more desirable curve, with a definite break at the borderline diameter of 10.5 cm. It was felt that this diameter, as determined radiologically, is the best measurement for prognostication at the outlet.

Clinically, midplane and outlet delay cannot always be differentiated. A plotting of the interspinous diameter gave a satisfactory curve with a critical diameter at 9 cm. Combining the data for the difficult low and mid-forceps deliveries did not change the nature of the curve.

It is concluded that there is no absolute level for predicting vaginal delivery of an uninjured infant, and that, therefore, resort to an elective cesarean section on a vertex presentation without labor is not justified.

The author discusses his methods of conduct of labor and reviews his results in groups of cases with and without elective section following trial of forceps application. The trial use of forceps is recommended in patients in whom there is lack of descent during the second stage of labor. If gentle traction and correction of unfavorable presentation does not permit delivery, cesarean section is advised.

Five graphs.

WALTER M. WHITEHOUSE, M.D.
University of Michigan

The Prediction and Management of Outlet Dystocia. D. Frank Kaltreider. Am. J. Obst. & Gynec. **67:** 1049–1066, May 1954.

This paper is based upon the same series of cases as that abstracted above and the observations are similar.

The intertuberous and posterior sagittal diameters as determined clinically were found to correlate poorly with the measurements obtained by x-ray pelvimetry. Moreover, the prediction of outlet dystocia on the basis of these measurements was not as accurate as determinations from the roentgen measurements of the anteroposterior diameter of the outlet. The greatest percentage of difficulty arose in patients in whom the roentgen measurement of the latter diameter was 9.5 cm. or under.

For prognosis, the author bases his considerations on the midplane and outlet as a unit. This he illustrates with a discussion of the relation of the fetal head at the outlet with its position in other pelvic planes.

His plan of management is to depend upon the interspinous and anteroposterior diameters for prognosis. A trial of labor is allowed and if normal delivery does not occur, forceps without excessive traction are applied. If the fetus fails to descend readily, cesarean section is done. With this plan, a significant reduction in fetal mortality was noted. The most difficult prognostic feature was found to be shoulder dystocia.

Fourteen illustrations; 10 tables.

OLIVER R. ROTH, M.D.
Jefferson Hospital, Philadelphia

THE GENITOURINARY SYSTEM

Evaluation of Diagnostic Procedures in the Study of Renal Masses. Earl Floyd, James L. Pittman, and J. Candler Guy. South. M. J. **47:** 426–430, May 1954.

The various procedures employed for the diagnosis of renal cysts and tumors are discussed and evaluated with regard to general indications for their use, ease and safety, accuracy, and information gained. The authors conclude that correctly interpreted pyelograms

are probably the most important means of differentiating renal masses. There are cases, however, in which one must use additional measures. Aortography, in selected cases, is very helpful and is frequently a deciding factor in arriving at the true diagnosis. In cases of suspected cyst the authors have found that a renal tap will occasionally obviate surgery. In their experience, nephrography adds little to the information obtained by aortography or by the rapid intravenous injection of an opaque medium.

Eight roentgenograms.

The Value of Aortography. William F. Melick. South. M. J. **47**: 421–426, May 1954.

The author presents 3 cases to illustrate the value of aortography in urinary lithiasis. When complete ureteral block exists and intravenous pyelography fails to reveal any evidence of renal function, aortography is the only available procedure for determining preoperatively the status of the kidney. Except in the case of tumor or tuberculosis, every effort should be made to save a kidney with an adequate blood supply. When the blood supply is inadequate, nephrectomy is usually indicated unless the opposite kidney is also involved in the ischemia. Aortography is also the only means of identifying the exact artery involved by a lesion.

The technic of aortography is described. It can be performed with readily available equipment. An ordinary 25-c.c. syringe, disposable plastic tubing, and a special thin-walled needle are all that are necessary.

Ten roentgenograms; 1 photograph.

Pneumoretroperitoneum in the Study of Malformations of the Kidneys. D. Gandini and A. Gibba. Radiol. med. (Milan) **40**: 417–438, May 1954. (In Italian)

The authors' procedure for pneumoretroperitoneum differs in no essential way from that commonly used except for the administration of two successive doses of gallbladder "dye" the night before and two successive "fatty-meals" the morning of the examination, to increase the density of the kidney substance.

Several cases of renal malformations are presented which leave no question as to the diagnostic value of pneumoretroperitoneum combined with laminagraphy. Only by this combined method was it possible to obtain the fine anatomic details of these malformations.

The value of the method is illustrated by the following examples: two cases of renal hypoplasia; a case of true supernumerary kidney, the third kidney being demonstrated in the pelvis, with no connection to the other two; a false double kidney with a bifid upper collecting system but a single renal parenchyma; a true renal duplication bilaterally (in effect, renal quadruplication); a horseshoe kidney with three excretory channels; 2 cases of renal ectopia.

The wealth of detail possible with this combined method of study is clearly brought out by the profuse illustrations. Such detail is not only of academic interest but is of practical value to the surgeon.

Forty-seven roentgenograms; 1 photograph.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Enuresis in Children. The Value of Radiological Investigation. J. M. Sheach. Proc. Roy. Soc. Med. **47**: 348–350, May 1954.

Of 276 urographic examinations on children in a two-year period, 164 (59.4 per cent) were done for enuresis, 108 in boys and 56 in girls. Nine of the children had a trace of protein in the urine and 10 had many pus cells with positive bacterial cultures (*B. coli* in 7).

Radiographic examination included a survey film of the urinary tract and intravenous urograms in all cases. Retrograde urography was done in only 7 patients. In 88 children the radiographic findings were normal; 25 had developmental anomalies, 33 showed trabeculation of the bladder, and in 23 there was significant residual urine. In 3 cases severe renal lesions were found: tuberculosis, hydronephrosis with ureterocele, and chronic pyelonephritis.

The developmental anomalies included a solitary right kidney, a horseshoe kidney, an ectopic left kidney, and several instances of double kidney with and without ureteral duplication.

Trabeculation of the bladder was due to bladder-neck hypertrophy in 18 cases and to cystitis in 6 cases. In 9 cases no cause was found.

Residual urine is not significant before the age of five. It was associated with bladder-neck hypertrophy in 10 cases.

Cystoscopy revealed significant bladder-neck hypertrophy in 44 cases. In 10, transurethral resection was required to relieve the obstruction.

Three roentgenograms; 1 graph.

PAUL MASSIK, M.D.
Quincy, Mass.

Renal Tuberculosis Masquerading as Simple Renal Cyst. G. L. Gryspeerdt and J. R. Thompson. Brit. J. Surg. **41**: 669–670, May 1954.

A 50-year-old female gave a history of tuberculosis of bone at the age of five, for which amputation of one leg had been performed. She had been treated for urinary symptoms at the age of thirty-four, and these had recurred in the six months before she was seen by the authors. Intravenous and retrograde pyelography and abdominal aortography suggested the presence of a space-occupying lesion in the lower pole of the left kidney, and a diagnosis of renal cyst was made. Laboratory studies were negative. Operation (heminephrectomy) revealed four cysts in the lower pole of the left kidney, subsequently proved to be tuberculous.

Two roentgenograms; 1 diagram.

PAUL MASSIK, M.D.
Quincy, Mass.

Primary Carcinoma of the Ureter. Anthony Baron and J. A. S. Green. Brit. J. Surg. **41**: 576–584, May 1954.

Eleven cases of primary carcinoma of the ureter are reported. This tumor has been seen most commonly in the sixth and seventh decades. The authors' oldest patient was seventy-seven years of age and their youngest forty-two. The usual clinical features are hematuria, pain, and tumor.

The plain film may show an enlarged renal shadow on one side. Intravenous pyelograms may reveal a nonfunctioning kidney or hydronephrosis. The most valuable diagnostic procedure is believed to be retrograde pyelography, since it may demonstrate ureteral obstruction or show a characteristic crescentic filling defect. It is, however, subject to certain errors of technic and interpretation, which must be guarded against.

Tumors of the ureter fall into three groups: papilloma, papillary carcinoma, and non-papillary carci-

noma. The papillary growths are frequently multiple and the solid growths single, but the two may coexist. The treatment of choice is nephro-ureterectomy. The prognosis has generally been considered poor, but the authors' series included survivals of four to seventeen years.

Fifteen figures, including 7 roentgenograms.

PAUL MASSIK, M.D.
Quincy, Mass.

MISCELLANEOUS

Importance of Survey Radiograph of the Abdomen in Surgery. Lewis E. Etter and Samuel M. Rice. Am. J. Surg. **87:** 624–628, April 1954.

Two cases are reported in which foreign bodies were left in the abdomen at operation and were subsequently demonstrated radiographically. In the first case the foreign body was a Jackson vaginal type of retractor. The patient had undergone five previous abdominal operations *without x-ray examination or evaluation of any kind*. The other patient had a retained x-ray-detectable sponge which was missed on a postoperative barium enema examination. No preliminary survey radiograph of the abdomen had been made.

In each of the cases presented a thorough historical background is given to illustrate how radiographic survey studies could have led to earlier detection of the foreign body.

Six roentgenograms.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Accuracy of Preoperative X-Ray Diagnoses of Breast Tumors. J. Gershon-Cohen, Helen Ingleby, M. B. Hermel, and S. M. Berger. Surgery **35:** 766–771, May 1954.

Roentgenograms of 210 breast lesions were interpreted by three roentgenologists, twice without and once with a knowledge of the clinical findings. The accuracy of the roentgen interpretation was greatest in the 163 benign lesions, being approximately 97 per cent. In the 47 cases of carcinoma, accuracy was never above 85 per cent.

The roentgenographic diagnosis of malignant lesions of the breast demands careful adherence to technical details and diagnostic criteria (see Gershon-Cohen *et al.*: Radiology **60:** 68, 1953), together with careful evaluation of the clinical findings. Most diagnostic failures could be placed in one of three groups: (1) technically unsatisfactory examination; (2) camouflage of malignant infiltration by the complex architectural components of a physiologically hyperactive breast in the younger woman; (3) inadequate consideration of the clinical findings.

Four roentgenograms; 3 photomicrographs; 1 table.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

TECHNIC

Simultaneous Telefilm Planigraphy. A Preliminary Report. Vidar Backlund. Acta radiol. **41:** 425–434, May 1954.

The author reports investigations designed to correct the undesirable features of conventional planigraphy, which usually takes a long time and involves considerable exposure of the patient to radiation.

Elimination of scattered rays, as far as possible, is not only essential to the production of satisfactory planigrams, but also reduces patient exposure. To accomplish this, the author uses a method based on that of Laurell (Acta radiol. **12:** 574, 1931). If a film is placed 15 cm. from (below) the object, without the addition of a fixed or movable grid, the picture will be technically adequate. However, in order to obtain the desired contrast, the focus must be adjusted according to the focus-film distance. For a distance of 150 to 200 cm., a 2 × 2-mm. focus is required; for 90 to 150 cm., a 1 × 1-mm. focus, and below this distance, 0.3 × 0.3 mm. A primary filter is also necessary. The great advantage of this "telefilm technic," as the author calls it, is the considerable reduction of the load on the roentgen tube.

With conventional vertebral planigraphy for examination of the lumbosacral region, the patient may receive as much as 720 r. With the method described here, this is reduced to 140 to 180 r, and still adequate penetration is obtained.

As a further step, the author has combined Ziedses des Plantes' "simultaneous planigraphy" method (Fortschr. a. d. Geb. d. Röntgenstrahlen **47:** 407, 1933) with the "telefilm technic." A "simultaneous cassette" (described in detail) was constructed for sections at 5-mm. intervals, so that several films are taken with a single exposure. This, however, involves a heavy load on the tube. The difficulty is avoided by combination with the "telefilm technic." The author found that 70 kv was the critical limit and that the milliamperage has to be adjusted so that the kilovoltage is above 70. Fast films and a suitable developer are used. In this way seven simultaneous films produced a radiation dose of 12 to 14 r on the skin, and only in exceptional cases of muscular male subjects with coarse and large vertebrae was a dose of 25 to 30 r reached with the fourteen pictures which were necessary.

The advantages of this technic are the considerably reduced skin dose, the rapid examination of many layers during the same phase of breathing, and the decreased number of exposures. One exposure, for example, will as a rule be sufficient for the gallbladder, kidneys, suprarenals, larynx, eyes, shoulders, hips, and spinal region. One, two, or three exposures are needed for other examinations, which the author enumerates. The disadvantage is that sections of 5-mm. distance are not obtainable at more than 22 cm. above the table, as the degree of enlargement will be too pronounced.

Sixteen roentgenograms; 4 photographs; 2 diagrams.

JULIAN O. SALIK, M.D.
Baltimore, Md.

The Visualization of Lymph-Nodes and Vessels by Ethyl Iodostearate (Angiopac) and Its Effect on Lymphoid Tissue. A Preliminary Radiological and Histological Study. H. S. Bennett and A. A. Shivas. J. Fac. Radiologists **5:** 261–266, April 1954.

A means of visualizing lymph nodes and lymphatics in animals by the intraperitoneal route is described. The contrast medium used was a micronized aqueous suspension of ethyl iodostearate marketed in Belgium under the name of Angiopac, and studies were done on both rabbits and rats. No toxic effects were encountered, but a selective necrosis of lymphoid tissue was noted. Complete regeneration was found to take place within six months.

The implications are briefly discussed, reference being made to the possible application of the technic in acquiring further knowledge of regional lymph drainage,

assessment of metastatic involvement, and therapy of neoplastic disease of the reticuloendothelial system. The importance of further investigation is stressed.

Five roentgenograms; 1 photograph; 3 photomicrographs.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Portable Thulium X-Ray Unit: I. The Portable Unit. S. Untermyer. **II. Methods for Preparing Thulium Oxide or Metal.** F. H. Spedding, A. H. Daane, and J. E. Powell. **III. Clinical Radiography with a Tm^{170} Source.** Robert J. Hasterlik. Nucleonics **12**: 35-37, May 1954.

This group of papers describes various aspects of the development of a portable radiographic unit employing the radioactive isotope thulium 170. Following the decay of the isotope, 84-kev gamma rays and 53-kev x-rays are emitted. The resultant spectrum is comparable to that produced by an 80-kv x-ray tube.

The portable unit is cylindrical in shape and weighs less than 7 pounds. The thulium is moved from a shielded position to the active position by means of a flexible cable. Such a unit is of great utility in isolated locations such as Army field hospitals, small naval vessels, etc. It is not an alternative to conventional x-ray tubes where these are available.

The method of refinement of thulium from the ore and its physical properties are described, and details of the activation of the metal by exposure to neutrons in a pile are presented, together with activity measurements.

Three radiographs demonstrate the effectiveness of the thulium unit.

Four figures.

JOHN S. LAUGHLIN, PH.D.
Memorial Center, New York

Scintillation Limitations to Resolving Power in Imaging Devices. John W. Coltman. J. Opt. Soc. Am. **44**: 234, 237, 1954.

The performance limit of a fluoroscopic image amplifier may depend on quantum fluctuation noise of the signal itself. The author investigates the ability of the eye to see a pattern delineated by random bright dots, for several contrasts (20 to 100 per cent) as it depends on the number of dots. [The fewer the number the greater the quantum fluctuation.] At 80 kv, 5 ma, 20-cm. abdomen, about 50,000 quanta per second per square millimeter come through (and 150,000 scattered quanta). From this the author calculates the resolving power for several contrasts. An ideal fluoroscopic image amplifier would have a brightness gain of 10,000 times in order to give image brightness where acuity of vision comes up to the resolution set by quantum fluctuation. This is considerably better than the resolution available from double screens on account of diffusion in the screens. [This supposes that the ideal amplifier does not throw away any of the direct quanta that come to it, *i.e.*, has 100 per cent quantum efficiency.]

R. R. NEWELL, M.D.
San Francisco, Calif.

Solid-State Image Intensifier. Richard K. Orthuber and Lee R. Ullery. J. Opt. Soc. Am. **44**: 297-299, 1954.

[Present fluoroscopic image amplifiers are bulky, deep. An image amplifier in the form of a sheet would not compel radical change from present fluoroscopic technics.] The authors describe an amplifier composed of a composite sheet of six layers. Between two conductive coatings on glass plates are a sheet of photoconductive material and an electroluminescent layer. Some 800 v of audiofrequency are applied to the conducting layers. If the photoconductive layer is of high resistance and thin compared to the electroluminescent layer, the voltage will be divided so that only a small fraction appears across the electroluminescent layer. This excites no glow. But if the photoconductive layer is illuminated and so becomes conducting, nearly full voltage appears across the electroluminescent layer and it lights up. The authors constructed such an amplifier 3 inches square, which achieved a brightness gain of $\times 2$. [This looks to be a long way from clinical usefulness, but one has to admire its cleverness.] The authors note a patent of a similar idea by W. White in August 1953.

Three illustrations.

R. R. NEWELL, M.D.
San Francisco, Calif.

RADIOTHERAPY

Cancer of the Lip. Control of the Primary Lesion. Henry Schwarz, II, and Joseph C. Lesser. Missouri Med. **51**: 355-359, May 1954.

From 1940 through 1950, 351 cases of histologically proved cancer of the lip were seen at the Ellis Fischel State Cancer Hospital, Columbia, Mo. Two hundred and fifty-two of these cases have now been followed for five years. The five-year absolute survival rate is 66.2 per cent. Excluding those patients who died of diseases other than lip cancer, the five-year net survival rate is 88.0 per cent. In 323 cases there were no clinically demonstrable cervical metastases at the time of treatment of the primary lesion, but metastases later developed in 32 of these; in 21 cases, regardless of the size of the primary lesion or the type of therapy employed, the cancer persistently recurred at the original site. Twenty patients had metastases which could be attacked surgically at the time of treatment; 8 cases could be treated only by palliation.

In terms of local control of cancer of the lip, radiotherapy and surgical excision produced roughly equivalent results. Criteria for selection of treatment are therefore based on terms of a functioning oral stoma and the cosmetic effects. While each patient must be considered individually, the following general plan of therapy is suggested.

Width of Tumor	Depth of Penetration	Type of Therapy
Small <1/2 lip	Shallow <1.5 cm.	Surgical excision
Wide >1/2 lip	Shallow <1.5 cm.	Radiation therapy
Wide >1/2 lip	Deep >1.5 cm.	Surgical excision with primary reconstruction
Wide >1/2 lip	Extension beyond lip to involve contiguous structures	Surgical block resection, usually with radical neck dissection

The authors have been unable to demonstrate any adequate rationale for prophylactic neck dissection.

Eight photographs; 1 graph; 5 tables.

Statistical Observations on 555 Cases of Epithelioma of the Lip Seen at the Tumor Center of Padua. Cesare Saggioro. Radiol. clin. **23**: 166–181, May 1954. (In Italian)

The statistical contents of this article are not readily abstracted. The 555 cases of lip cancer seen at the Tumor Clinic in Padua are broken down according to sex, age, site (upper or lower lip and position on lip), duration of the lesion before treatment, stage of the lesion, histologic type, gross type, presence or absence of adenopathy (the term adenopathy is used rather than metastasis, because histologic study was not performed on all the cases with palpable nodes), the technic of treatment, and results. These data are compared with others reported in the literature, and some explanations for certain discrepancies are offered.

Treatment of these cases consisted of either surgery alone or a combination of surgery and irradiation. For irradiation, radium and roentgen rays were employed, either singly or together. The very extensive lesions were treated with contact radium molds. For roentgen therapy of primary lesions, a dose of at least 3,600 r was given in one sitting, or 1,200 r were administered daily on three successive days, with varying filtration. Roentgen therapy was used almost routinely for treatment of the lymph nodes after the primary lesion had been treated either by roentgen rays or by radium. Combined therapy (radium, surgery, and roentgen rays) was the preferred treatment with adenopathy: radium for the primary lesion, surgery for regional lymph node extirpation, and roentgen therapy for subsequent irradiation of the submandibular and lateral cervical fields. In some cases, roentgen therapy alone was used both for the primary lesion and lymph nodes.

Following such treatment, the crude survival rates were: 80 per cent after three years, 74 per cent after five years.

Ten tables.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Present Trends in Treatment of Carcinoma of the Larynx. R. G. Macbeth. Irish J. M. Sc., pp. 141–156, April 1954.

The author's purpose in this review of carcinoma of the larynx is to suggest that surgery is preferable to radiotherapy for almost all examples of this disease. He bases his conclusions on published reports and his own personal experience. They are, in part, as follows:

"In favour of radical excision is a high 5-year-cure rate; in favour of irradiation is retention of vocal and respiratory functions.

"An average of the most reliable percentage figures obtainable shows that in early cordal lesions median thyrotomy offers a 10 per cent better chance of 5-year cure than does irradiation.

"A similar comparison of results in cases suitable for total laryngectomy shows an average 5-year-cure rate of 34.7 per cent for irradiation and 62.6 per cent for surgery, *i.e.*, 28 per cent in favour of surgery.

"Figures for extrinsic and advanced cancer, with secondary nodes present or likely, are not readily obtainable. All methods of treatment have been disappointing. Modern techniques allow of major resections, and these probably offer the best hope.

"Radical neck dissection for lymph nodes should accompany the excision of all growths which have ceased to be confined to the true cords."

In one limited group of cases, *i.e.*, where the primary tumor is to be irradiated but the nodes are operable, the author differs from most authorities. He does a radical neck dissection followed by irradiation in ten days.

One roentgenogram; 7 photographs; 5 tables.

PAUL MASSIK, M.D.
Quincy, Mass.

Roentgen Therapy of Hepatic Metastases. Ralph Phillips, David A. Karnofsky, Leonard D. Hamilton, and James J. Nickson. Am. J. Roentgenol. **71**: 826–833, May 1954.

The old fear of treatment of the liver by radiation has been dispelled by the authors. They have thoroughly investigated the use of supervoltage (1,000 kv) roentgen therapy of metastatic lesions to the liver and have found that the incidence of severe liver damage and symptoms of nausea and vomiting are not such as to warrant the withholding of radiation therapy for palliation.

Thirty-six cases were treated at Memorial Center (New York) for metastases secondary to carcinoma of the breast, bronchus, and gastrointestinal tract. Twenty-six out of this series of 36 patients received symptomatic relief, and in most cases normal blood chemistry was restored after several days of radiation therapy. One case, which is discussed in detail, showed a rather remarkable return to normal of all of the important blood chemistry relationships with the exception of the albumin-globulin ratio. Although the abnormal findings eventually recurred, life was prolonged and the symptomatic relief was remarkable.

Treatment consisted of supervoltage roentgen therapy alone in 22 cases; in 14 cases a single intravenous dose of nitrogen mustard was given prior to the first roentgen treatment in an attempt to prevent the initial edema which is supposedly present immediately after irradiation is begun. Anterior and posterior fields, usually measuring around 25 × 25 cm., were used, and a total tumor dose of 2,000 to 3,750 r was administered. The rate of treatment was rather rapid, varying from eight to twenty-two days, with the shorter period of time being more usual. The choice of rapid therapy was dictated by the fact that the treatment was palliative and that the patient was free of symptoms sooner and at less expense.

Autopsy in 12 cases showed varying degrees of necrosis of the liver metastases in 10; in 2 there were no visible radiation effects. A frequent finding on postmortem examination was the fibrous encapsulation of a metastatic lesion. One case showed complete disappearance of all the malignant cells.

The use of grid therapy in the 250-kv range is also discussed. It is considered "the poor man's supervoltage."

Two figures; 10 tables.

OTIS M. RICHARDSON, M.D.
University of Louisville

The Influence of Systemic Factors on the Reaction to Radium of the Normal and Malignant Epithelium of the Uterine Cervix. C. P. Cherry and A. Glücksmann. Cancer **7**: 504–518, May 1954.

A statistical analysis of changes in the benign cervical

epithelium and in cancer of the cervix secondary to radium treatment was undertaken in 55 premenopausal and postmenopausal women. These patient groups were further subdivided into radiocurable and radioincurable.

All patients had squamous-cell carcinoma of clinical Stages I and II. All were treated with three insertions of radium over a period of twenty-one days. Doses were of the order of 3,400 mg. hr. for the first insertion and 1,700 mg. hr. at the second and third insertions, at seven-day intervals thereafter. No roentgen therapy was given. The cervix was excised about eight weeks later.

Serial biopsies were taken before beginning treatment at the end of the first seven days, and at the end of fourteen days. The height of the normal epithelium and the total cell population per unit volume, as well as the number of basal, transitional, and cornified cells, were determined in the biopsy material and correlated with the local result of radium therapy.

No significant difference was found in the response of the above noted groups to the first course of radium, as determined seven days subsequent to insertion. Seven days after the second course of radium (fourteen days after start), however, statistical differences within the groups were apparent, though with some overlap of individual reactions. The greatest response of the benign epithelium was in patients who had passed the menopause, whether or not the tumor responded, and in premenopausal patients whose cervical cancers did respond to radium.

The authors suggest that the "systemic factors influencing the response of benign and to some extent of malignant tissues are linked to changes in hormonal activity or responsiveness in the menopause rather than to an individual or host radiosensitivity." Whether these systemic influences are identical with the estrogens and how they act to produce their effect are problems requiring further research.

Fifteen photomicrographs; 5 graphs; 5 tables.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

The Vaginal Smear as a Prognostic Aid in Carcinoma of the Cervix Treated According to the Individualized Stockholm Method. Gertrude Kohn. Acta radiol. **41**: 446–452, May 1954.

It has been shown by Graham (Surg., Gynec. & Obst. **84**: 153, 166, 1947. Abst. in Radiology **50**: 141, 1948) that the prognosis in cases of carcinoma of the cervix can be made, during the course of radiation therapy, on the basis of the radiation changes observed in the benign cells in vaginal smears. Using the technic described by Graham, the author in a series of 50 cases has attempted to duplicate her work. This technic is safe and simple, and is preferred to serial biopsy. The latter procedure has not been used at the Radiumhemmet in recent years because experience has proved that any kind of a rupture of the cervix should be avoided and that the healing process should be undisturbed.

A vaginal smear was made on the 14th day after irradiation was begun, at which time changes are maximum, and 100 benign epithelial cells were classified as to radiation changes. These cellular changes are reviewed, and the criteria employed are discussed. In this series, 32 cases showed a good response, with more than 65 per cent of the cells showing some type of radiation effect. A twelve- to twenty-month follow-up revealed that 27 of the 32 patients were well and symptom-free; only 5 had had recurrences. Of the 18 patients with a poor response (less than 65 per cent of cells showing change), 16 had persistent disease or recurrence.

If a good response was not apparent after the initial treatment, the response after a second application did not show sufficient change to warrant reclassification. Since the cells are shed from the surface epithelium, the smear is of no significance in evaluation of the reaction of the deeper parts of the lesion to the therapy. The presence or absence of malignant cells on the smear during treatment was found to be an unreliable factor.

The author considers this method of great value in assessing individual treatment of the patient.

Two tables.

C. M. GREENWALD, M.D.
Cleveland Clinic

The Prognostic Value of Eosinophilic Leucocytes in the Stroma of Carcinoma of the Cervix Uteri. A Study of 291 Cases Treated with Radium and Roentgen Therapy. F. Linell and B. Månsson. Acta radiol. **41**: 453–456, May 1954.

The occasional occurrence of masses of eosinophilic leukocytes in the stroma of malignant tumors, particularly in squamous-cell carcinoma, is a known fact, though their significance has been subject to much speculation. Some workers believe that marked eosinophilia in carcinoma of the uterine cervix is prognostically favorable.

In an attempt to elucidate this point, the authors analyzed 291 cases of squamous-cell cervical carcinoma which were grouped, chiefly on the basis of biopsy specimens, as to the degree of eosinophilic infiltration. Comparisons with the clinical stage (League of Nations classification) and with the histologic grade of the lesion are presented in two tables. The proportion of eosinophilic leukocytes in the stroma was found to have no apparent influence on the outcome in this series, and is considered to be of no prognostic value.

C. M. GREENWALD, M.D.
Cleveland Clinic

Routine Measurement of the Rectal Dose in the Treatment of Carcinoma of the Cervix by Radium. T. J. Deeley. J. Fac. Radiologists **5**: 289–291, April 1954.

In an attempt to determine the amount of radiation that can be safely given to the anterior rectal mucosa in the radium treatment of carcinoma of the cervix, measurements of rectal dose were made by means of ionization chambers inserted in the rectum. Four charged standard Farmer ionization chambers, of external diameter 1.0 cm., placed in tandem in a thin brass tube, were used. It was found convenient to make the measurements immediately after insertion of the radium, with the patient still under the anesthetic. Dosage calculations from radiographs obtained with the radium system in place were made in some instances and seldom differed by more than 5 per cent from the measured doses. All the patients were followed carefully, and only those who were without evidence of recurrence after twelve months are included in the present study. The series numbers 104.

A maximum dose of 5,000 r to the rectal mucosa was found to be the critical dose when treatment is solely by radium. In 1 patient a true proctitis developed

following a dose of less than this amount, an incidence of 1.6 per cent. With a rectal mucosal dose of 5,000 to 5,600 r, 23 per cent of the patients had severe rectal reactions.

The author also calculated rectal doses in patients treated by radium followed by radical surgery. He concludes that the maximum rectal mucosal dose should not exceed 3,750 r when surgery is planned.

Two tables. RICHARD A. ELMER, M.D.
Atlanta, Ga.

Carcinoma of the Body of the Uterus. W. G. Cosbie, W. Anderson, O. B. Millar, and M. L. Bunker. Am. J. Obst. & Gynec. **67**: 1014–1024, May 1954.

From 1937 to 1952, 421 cases of endometrial cancer were seen at the Toronto General Hospital. These cases represent a broad clinical grouping. The average age of the patients was fifty-nine years, ranging from twenty-six to ninety, with the greatest number between fifty-five and sixty-four. The classification was: operable, technically operable, and inoperable. The inoperable cases (advanced disease) and the technically operable (operation contraindicated by age or for medical reasons) were treated by intravaginal as well as intracavitary radium and 400-kv roentgen irradiation delivered to six pelvic ports. The operable received intracavitary radium followed in six weeks by total hysterectomy and bilateral salpingo-oophorectomy. A few of the better surgical risks with involvement of the lower portion of the uterus also had pelvic lymphadenectomy.

Radium application was of three types. In a small uterus either two tandem pairs with a length of 4.5 cm., containing 60 mg. of radium, were used, or three tandem pairs with a length of 6 cm., containing 60 mg. of radium. In the large or distorted uterine cavity multiple applicators were employed. These applicators consisted of aluminum containers 3 cm. long, into which fitted 2.2-cm. radium tubes with 1.0-mm. platinum filter. Six applicators at the fundus and four at the cervix proved to be a satisfactory arrangement. The pattern of the isodose curves was plotted about the various forms of applicators. Two applications within a month were used when radiotherapy was the only treatment, to take advantage of the decrease in the size of the uterus and tumor following the primary application.

The five-year survival rate for the entire series was 46.2 per cent. With planned therapy, including preoperative radium plus hysterectomy, the five-year survival rate was 84.6 per cent and for all surgically treated cases 72.9 per cent. Residual carcinoma following irradiation and myometrial invasion definitely affect the survival rate. It is the opinion of the authors that the planned method of treatment gives the best results; the improvement over the sixteen years they attribute to the increasing use of preoperative radium.

One roentgenogram; 3 isodose curves; 6 photomicrographs; 11 tables. ROBERT L. EGAN, M.D.
Jefferson Hospital, Philadelphia

Treatment of Testicular Tumours by Radiotherapy. R. G. Moffat. Canad. M. A. J. 70: 542–546, May 1954.

This paper, a rather general discussion of the treatment of testicular tumors by irradiation, was presented at a meeting of the Canadian Medical Association. The author's conclusions, based on a series of 45 cases, are as follows: (1) Testicular tumors appear mainly in patients between twenty and forty years of age. (2) The diagnosis may be in doubt if the entire organ is not removed for histologic examination and adequate classification. (3) Efficient irradiation to the lymph node areas can double or triple the five-year survival rate of simple orchiectomy. The value of lymph node dissection has not been proved. (4) Irradiation should follow orchiectomy immediately. If it is delayed until metastases are clinically demonstrable, the survival rate is halved. (5) In tumors of a radioresistant type, radiation dosage to metastatic areas should be taken to full tolerance with adequate protraction in the first planned treatment. (6) Excessive size of abdominal or other metastases does not preclude cure or worth-while palliation with irradiation. Even some patients with radioresistant tumors and pulmonary metastases can be cured by irradiation. (7) The detrimental effect of irradiation on gastrointestinal mucosa, renal parenchyma, spinal cord, and bone marrow makes necessary the utmost care in planning treatment and careful continuous supervision.

Twenty-two of the 45 cases were treated more than five years ago, and the five-year survival rate for these cases is 77 per cent. Sixteen of the 22 cases were seminomas, and only 1 patient in this group failed to survive for five years. Only 1 of 4 patients with teratocarcinoma survived five years. One of 2 patients with embryonal carcinoma lived eight years in spite of pulmonary metastases on admission. Patients treated less than five years ago already have a survival rate of less than 70 per cent because of a much higher proportion of tumors of radioresistant type in the later group.

Lymphogranulomatosis and Pregnancy. H. Hartweg and H. Braun. Strahlentherapie **94**: 213–222, 1954. (In German)

The authors have collected from the literature 93 instances of pregnancy in 76 women with Hodgkin's disease. They have themselves observed an additional 28 cases in 22 women, and these they report. Since the course of the disease seems not to have been unfavorably influenced in any of these cases, it is concluded that interruption of pregnancy for Hodgkin's disease is not indicated. If, however, the disease develops during the course of the pregnancy, the prognosis becomes worse.

Since the average survival in Hodgkin's disease is about six years, marriage is held to be inadvisable. Pregnancy is not a contraindication to radiotherapy expertly administered, but chemotherapy is best omitted.

Two tables. LEWIS L. HAAS, M.D.
University of Illinois

Giant Follicle Hyperplasia: A Study of Its Incidence, Histopathologic Variability, and the Frequency of Sarcoma and Secondary Hypersplenic Complications. Theodore S. Evans and Charles A. Doan. Ann. Int. Med. **40**: 851–880, May 1954.

"Giant lymph follicle hyperplasia" is a morphologic term of the pathologists applied to a wide range of clinical syndromes without a known etiologic factor. The authors focus their attention on the characteristics which distinguish this from the other lymphomata and upon the high frequency of secondary hypersplenic, cytopenic complications. Their study is based upon 16 cases, all of which were followed for a number of months

or years. This provides a large comparative clinical material.

The incidence of splenomegaly in this series was 70 per cent. Eight patients (50 per cent) required splenectomy for more or less acute cytopenic episodes. Three of this group had acute hemolytic anemia as the predominant hematologic complication; 2 presented with thrombocytopenic purpura; 1 had a profound neutropenic leukopenia and a thrombocytopenia; and the remaining 2 had a peripheral pancytopenia involving all of the circulating formed elements of the blood. Each of these syndromes was promptly reversed by the surgical removal of abnormal splenic tissue. Eight patients were without hypersplenic, cytopenic complications.

Certain distinct impressions have been obtained from a critical review of the medical literature dealing with "giant lymph follicle hyperplasia." (1) This condition is usually reported as a clinical syndrome involving both lymph nodes and spleen, but without other specific features, and may be differentiated from other lymphomata only by microscopic tissue examination. (2) Meager hematologic data have been obtained and relatively few bone marrow studies have been reported in patients with this diagnosis. (3) The outstanding histologic feature is follicular hyperplasia with prompt and prolonged response to roentgen therapy, radioactive phosphorus, or other lymphopoietic suppressive measures.

The unique "giant lymph follicles" are discrete. Later they may fuse and break through their ordinary structural boundaries. In some individuals, an apparently simple functional lymph follicle hyperplasia may terminate in a clinical and hematologic picture characteristic of lymphosarcoma, Hodgkins' syndrome, or lymphatic leukemia. The fundamental cause of each is different.

A relatively benign, perhaps functional, reticuloendothelial cell hyperplasia appears to underlie and to be responsible, at least in part, for the development of the abnormally enlarged germinal follicular centers in this condition.

When the spleen becomes involved and enlarged in one of these processes, hypersequestration of one or more of the circulating blood cell types frequently occurs. An absolute peripheral cytopenia with characteristically related clinical manifestations may then develop. The suspected dysplenism may be confirmed through the successful surgical removal of the spleen, followed by the prompt re-establishment of a normal circulating cellular equilibrium. If a recurrence of the original cytopenic syndrome develops, as in two instances reported in this paper, the presence of an accessory spleen should be suspected.

Eight photomicrographs; 4 charts; 2 tables.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Treatment of the Common Wart by X-Ray Therapy. Alan Nelson. M. J. Australia **1**: 669–671, May 1, 1954.

The treatment of warts with x-radiation has proved very successful. It is important, however, that they be differentiated from other lesions such as corns, which require different management. Warts have a characteristic fleshy appearance with tiny black or bloody spots in the center, which may not be apparent until the overlying callus is pared away.

The present series of warts included 140 cases, the majority of which were plantar; 127 cases responded favorably to routine irradiation; 1 case required surgery; 12 cases yielded to special supplemental treatment.

All warts in adults may be treated by x-rays. Multiple warts and warts over the epiphyses in children are better treated by other methods. Warts beneath the finger nails require special treatment.

The technic is as follows. After removal of excess callus, the wart is ringed with a close fitting lead shield, which allows only a 1- to 2-mm. border of normal tissue. With 100 kv, no filter, and 16 cm. distance, three doses of 900 r each are given in two weeks. In four weeks the patient may return for removal of callus and dead tissue. In 9 of the author's cases the base remained soft and granulomatous. These were given an added dose of 900 r. Such additional treatment can be given to small areas. It is advisable to prevent callus formation by proper foot care and correct shoes.

PAUL MASSIK, M.D.
Quincy, Mass.

Dose Definition and Dose Measurement in the Supervoltage Range. R. Glocker. Strahlentherapie **93**: 1–14, 1954. (In German)

After a general discussion of the problems of dosimetry in the supervoltage range up to 31 mev, the author describes his experience with dosimeters with liquid and solid detectors. The recently available CdS crystals have a pronounced wave-length dependency, which was determined experimentally and found to agree well with the theoretical values. Most promising is the use of fluorescent substances in combination with photomultiplier tubes. A mixture of 75 per cent Anthrazene and 25 per cent 2-Chloranthrazene in a layer of 0.5 mm. thickness was used. Depth curves taken with this instrument for the 31-mev betatron agreed well with ionization measurements. The author points out that air is not suitable for universal dosimetry, because its electron absorption compared with that of water varies considerably between 1 and 1,000 mev, showing a minimum of 15 per cent at about 100 mev.

Ten figures. ULRICH K. HENSCHKE, M.D.
Ohio State University

Depth Dose Measurements in Human Brain Tissue. J. Cederlund, K. Lidén, and M. Lindgren. Acta radiol. **41**: 473–477, May 1954.

Depth dose measurements in brain tissue and calculation of its effective atomic number were found to be, within the limits of error, the same as in water. The authors point out that this finding is in disagreement with the statements by Wachsmann (Acta radiol. **32**: 145, 1949) and Vetterlein (Dissertation, Erlanger, 1949), that the absorption coefficient of brain tissue lies between bone and water, being 50 per cent greater than water at h.v.l. of 1 mm. Cu. These earlier observers erroneously calculated the effective atomic number of brain tissue as 10.9, whereas the present authors find it to be 7.5 ± 0.1 (water being 7.42).

Provided proper corrections are made for the absorption of bone and for the effect of the small volume of the skull, standard depth dose tables can be used for dosage calculations in treating brain lesions.

One graph; 2 tables. C. M. GREENWALD, M.D.
Cleveland Clinic

A Rapid Method of Positioning for Rotation Therapy. J. Dresner. Am. J. Roentgenol. **71**: 867–869, May 1954.

One disadvantage of rotation therapy has been the long period required to position the patient correctly. A method is here described which reduces the time to about three minutes. The horizontal roentgen beam is first adjusted so that it passes over the center of the circular rotating platform, through an imaginary vertical axis. The patient is strapped in the chair; the platform is turned to zero position (*i.e.*, with the traverses upon which it is mounted respectively parallel and perpendicular to the x-ray beam); a specially designed pointer attached to the x-ray machine is set for the skin-tumor distance, and the patient is moved over the traverses until the reference mark on the pointer touches the tip of the pointer. The tumor is now in the center of rotation.

The overall accuracy of this method has been verified by taking roentgenograms with the 2-mev beam after the patient has been positioned. Additional verification has been obtained in cases where mucosal reactions in the mouth were found to correspond to the calculated limits of the field after the course of treatment.

Three figures.

OTIS M. RICHARDSON, M.D.
University of Louisville

RADIOISOTOPES

General Methods of Application of Radioactive Isotopes to Therapy and Diagnosis. Dosage, Control, Protection. G. Joyet. Schweiz. med. Wchnschr. **84**: 491–499, May 1, 1954. (In French)

Of the large number of radioactive isotopes that can be produced in the atomic pile or by the particle accelerators, only about half a dozen are utilized in medicine for therapeutic or diagnostic purposes. There are three fundamental reasons for the limited therapeutic application, in contrast to early expectations: (1) the general distribution of the radioactive isotopes in the organism, (2) a dangerous selectivity for the hematopoietic system, and (3) a long-term fixation in the bones.

It is difficult to modify significantly the concentration of an isotope in a given tissue by any physiologic means. The author shows this by some data concerning K^{42} uptake in spontaneous cancer of the breast in mice, with an attempt at modification of tissue selectivity by adrenalectomy, preliminary administration of desoxycorticosterone acetate or calcium chloride, and a low potassium diet. The limited success with localization of the radioactive isotopes by a physiologic route has led to local applications, notably (1) the intrapleural or intraperitoneal use of colloidal gold (Au^{198}), or its incorporation in a tumor, (2) endocavitary applications of a radioactive solution contained in a rubber balloon, and (3) the use of needles or seeds of Co^{60}.

In computing dosage, the author uses the concept of *rads*, one of which is equal to 100 ergs dissipated per gram of tissue. Since the amount of energy dissipated depends on the radioactivity concentrated per gram of tissue, one should know, on the one hand, the absolute radioactivity of the quantity of isotope administered and, on the other, its distribution in the tissues. The dosage in units of absorbed energy is very different when the isotope has a generalized distribution than when it is localized.

With the aid of a dosage chart of P^{32}, correlating rads with the weight of the patient and the activity of the radiophosphorus injected, and a clinical chart demonstrating how the hemoglobin and red and white blood counts varied with the amount of isotope injected, the treatment of a case of myeloid leukemia is described, P^{32} being taken as an example of those isotopes with general distribution in the body.

Similarly, a dosage chart is given for Au^{198}, equating rads, in terms of millicuries injected, and the volume into which the colloidal gold is introduced. A similar treatment is accorded I^{131} for diseases of the thyroid; knowing the dose in rads, one is able to determine the total radioactivity necessary for treatment as a function of the volume of the gland and elimination.

In the diagnostic field, I^{131} occupies first place because of its suitability for determining thyroid function. Because of the contradictory reports in the literature, diiodofluorescein tagged with I^{131} for the localization of brain tumors has not been used in the author's laboratory.

Use of the radioelements exposes hospital personnel to the dangers of penetrating gamma radiation, beta radiation and, even more serious, the introduction of the isotope into the body *via* mouth, lungs, skin, or open wounds. The author presents a table in which the radioelements are divided into three groups, according to the dangers involved, showing the slightly dangerous, the moderately dangerous, and the very dangerous levels for each. Precautionary measures both for the hospital personnel and the patients are outlined. While the dangers of the gamma emitters are the most serious, under certain conditions the sources of beta radiation can also be dangerous.

Sixteen figures; 7 tables.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Radiology: Biochemical Consideration of Distribution. Granvil C. Kyker. Am. J. M. Sc. **227**: 572–589, May 1954.

In this paper, which appears in the section "Progress of Medical Science," the author reviews the investigations that have been carried out on the distribution of radioisotopes in the body. He illustrates these by certain studies of yttrium currently in progress at the Oak Ridge laboratories.

A bibliography of 77 references.

Results of Radioactive Isotope Encephalography in Patients with Verified Intracranial Tumors. Loyal Davis and Thomas Craigmile. J. Neurosurg. **11**: 262–267, May 1954.

This paper constitutes a review of the results of encephalography with radioactive diiodofluorescein and radioactive sodium iodide in 200 patients with primary or metastatic intracranial tumors verified at operation or autopsy. It is apparently an enlargement on work previously reported (J.A.M.A. **144**: 1424, 1950. Abst. in Radiology **57**: 765, 1951). For a fuller description of the scanning technic the authors refer to the earlier paper.

The main theme here is a comparison of the accuracy of localization with fluorescein and with sodium iodide.

Group size is, however, disproportionate. In the fluorescein group, 159 patients were studied; in the sodium iodide group, 41. In patients with primary tumors studied after administration of diiodofluorescein there was accurate localization of the verified lesion in 61.6 per cent, while radioactive sodium iodide afforded precise localization of primary tumors in 52.8 per cent of the examinations.

In 21 patients with verified metastatic tumor, studies with fluorescein revealed evidence of an organic lesion in 76 per cent, with precise localization of a solitary metastatic nodule in 47.6 per cent. With sodium iodide, used in 5 patients with metastatic intracranial tumor, only 1 abnormal tracing was obtained.

The present figures do not compare well with the 95.5 per cent accuracy of the previous report.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Which I^{131} Counting System is Best for Laboratory Use? John H. Weisburger and Harry J. Lipner. Nucleonics **12**: 21–23, May 1954.

A comparative study was made of the relative efficiencies of various counting systems for I^{131} and other radioactive isotopes. A well-type scintillation counter, an end-window Geiger-Müller counter, a windowless Geiger-Müller counter, and a windowless proportional counter are rated on their efficiency as determined by the ratio of counts recorded to the absolute number of disintegrations and on the minimum activity which they can detect with an accuracy of ±10 per cent. Their comparative convenience of use is also evaluated.

The scintillation counter system, which responds primarily to gamma rays, was found to have an efficiency of 48 per cent. The other counters respond primarily to beta particles. The two windowless counters had an efficiency of the order of 46 per cent, while the Geiger-Müller end-window counter was 25 per cent efficient. The minimal detectable activities are not greatly different for the various counters. The scintillation counter is preferred because of the greater reproducibility of count and elimination of self-absorption effects. However, Geiger-Müller counting tubes are also effective and are less expensive.

Two figures; 1 table. JOHN S. LAUGHLIN, PH.D.
Memorial Center, New York

Radio-iodine Measurements of Thyroid Function During and After P.A.S. Treatment of Tuberculosis. J. A. Balint, Russell Fraser, and M. G. W. Hanno. Brit. M. J. **1**: 1234–1237, May 29, 1954.

Hypothyroidism with goiter occurring as a complication of treatment with para-amino salicylic acid (P.A.S.) has been reported 9 times in three years. Instances of enlargement of the thyroid gland also have been reported in patients receiving P.A.S.

To determine the influence of the drug on thyroid uptake, the authors performed radioiodine tests immediately preceding and four to seven days following its withdrawal in 30 patients having tuberculosis. A higher urinary excretion of I^{131} was observed while the patients were on P.A.S. than after its withdrawal. During P.A.S. administration, uptake of radioiodine by the thyroid was slowed on the first day after administration, but the total uptake over a forty-eight hour period was approximately the same as in normal controls.

After withdrawal of P.A.S., radioiodine excretion was less than in normal controls and thyroid uptake was increased, indicating some depletion of the thyroid hormone store during the previous drug therapy. In the opinion of the authors, this is an indication that P.A.S. has some weak antithyroid activity. *In vitro* tests indicated that Isoniazid also exerts an antithyroid effect, but an even weaker one than P.A.S.

The antithyroid effect of P.A.S. is considered to have clinical importance only in patients who have been taking the drug for six months or more. Of 11 such patients, 10 were found to have an obviously avid uptake of radioiodine on withdrawal of the drug, and in 4 small goiters developed. In 2 of these patients, the abnormalities were correctable by iodide, and the authors suggest that when P.A.S. is to be given for more than six months a potassium iodide pill (20 mg.) should be given weekly.

Four tables. ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Modification of Maternal and Fetal Effects of Radioiodine by Pretreatment of the Mother. Roberts Rugh and Elisabeth Booth. J. Pediat. **44**: 516–533, May 1954.

Groups of white mice were treated during pregnancy with thiouracil, methimazole, and thyrotrophic hormone, following which they were given radioiodine. The study was designed to determine any modification in uptake, distribution, or anatomical effect of radioiodine on maternal or fetal thyroids by the thyroid-affecting compounds administered. Pregnant and non-pregnant mice receiving only radioiodine were used as controls.

The results suggest the following conclusions:

1. Pregnancy alone seems to promote iodine retention.
2. Thyrotrophic hormone promotes greater retention of iodine.
3. Antithyroid compounds cause less retention of iodine.
4. Prior treatment of pregnant mothers with antithyroid compounds results in a greater retention of iodine by the mother than by the offspring, a ratio of about 3:1, as compared with a ratio of 1:1 in controls.
5. Thiouracil administered to the pregnant mother prior to administration of radioiodine protects the fetal thyroid from histologic radionecrosis. Methimazole does the same to a lesser degree.
6. Thiouracil alone seems to afford protection in all cases against reduction in size of the fetal thyroid.

Four tables; 15 photomicrographs; one graph.
H. G. PETERSON, JR., M.D.
New Britain, Conn.

Impaired Organic Binding of Radioiodine by the Thyroid Following Radioiodine Treatment of Hyperthyroidism. Richard H. Kirkland. J. Clin. Endocrinol. & Metab. **14**: 565–571, May 1954.

There has been some controversy as to whether or not there is a change in thyroid function following therapeutic dosages. The author here presents evidence of a specific change following such therapy. It has been noted that organic binding of iodine trapped by the thyroid does not occur during thiouracil therapy; a similar impairment of organic binding takes place when inorganic iodide is given in sufficient dosage to raise the serum iodide level to 20–35 micrograms per 100 c.c.

The shape of the normal radioiodine uptake curve

depends upon at least two functions: the ability of the thyroid to trap the iodide and to bring about its organic binding. The ratio between the thyroid iodide and the serum iodide is reached within the first two hours and is a measure of the iodide-trapping mechanism. This function is abolished by the presence of the thiocyanate radicle.

With these facts in mind, 20 patients were given 50 microcuries of radioiodine and one- and three-hour determinations were made. Following the three-hour determination, 2 gm. of sodium thiocyanate was given by mouth, and determinations of uptake were made at fifteen-minute intervals for at least two hours. The lowest radioiodine content of the thyroid following this was expressed as a percentage of the radioiodine content of the thyroid immediately before the drug was administered. This percentage was considered to represent a fraction of the iodide which had become organically bound. Similar observations were made in 10 patients with hyperthyroidism who had been treated with radioiodine, all of whom showed an "injury type" of uptake curve which is characteristic of deficient or blocked organic binding.

The control group showed an average of 96.6 per cent organic binding of the trapped iodide or, in other words, an average loss of 3.4 per cent, following the administration of thiocyanate. The treated group of hyperthyroid patients showed an average of 45.9 per cent organic binding of the trapped iodide or an average loss of 54.1 per cent following thiocyanate. The observations seem to indicate that radioiodine acts upon the thyroid in such a manner as to prevent or impair organic binding of trapped iodide.

Two graphs; 1 table. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Effect of Thyrotropin on Changes in Thyroid Function Following Administration of I^{131} to Euthyroid Cardiac Patients. G. S. Kurland, A. S. Freedberg, and J. Fishman. J. Clin. Endocrinol & Metab. **14:** 572–578, May 1954.

Because of the absence of alteration in the normal histology of the thyroid gland in the presence of altered function following rather massive doses of radioiodine in euthyroid cardiac patients, the question arose as to whether or not the functional changes consequent to the radioiodine radiation were reversible.

Seventeen patients with angina pectoris and 12 patients with congestive heart failure received multiple doses of I^{131}, and the twenty-four-hour thyroidal uptake and biological half-life of the isotope were measured. The uptake of the second therapeutic dose of radioiodine, given seven to fourteen days after the first, was markedly diminished and it was turned over at a more rapid rate. In the angina pectoris patients, the average biological half-life was reduced from six days to two days, and the average uptake from 32 to 10 per cent. A similar decrease of uptake and half-life was observed in the congestive heart failure group. This marked depression of uptake accompanied by a rapid turnover did not occur when thyrotropic hormone (TSH) was administered before the second dose. In 4 patients the uptake of the second dose averaged 43.8 per cent and the biological half-life 6.9 days. In 3 other cases the uptake was in the thyrotoxicosis range.

The data thus obtained would indicate that TSH remains capable of stimulating radioiodine uptake when administered as long as fifty-four days after a therapeutic dose. The possibility cannot be excluded that the initial effect of radioiodine radiation, antedating any anatomical change, may be the inactivation of thyroid gland enzymes.

One graph; 2 tables. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Report of Work with I^{131} at the Royal Melbourne Hospital. R. Kaye Scott. Australian & New Zealand J. Surg. **23:** 273–279, May 1954.

Radioiodine became available in Melbourne (Australia) in 1948, and the author reviews both the diagnostic and therapeutic applications of the isotope since that time. He describes particularly a new counting system devised by Clarke of the Commonwealth X-Ray and Radium Laboratory in 1952 for measuring the uptake of iodine in the thyroid gland: 20μc of I^{131} are injected intravenously, and twin counting chambers, one on each side of the neck, survey the uptake over the first thirty minutes following the injection. An index based on the uptake curves thus obtained was found to be in very reasonable agreement with independently observed clinical hypo-, hyper-, and euthyroid states, and the findings have been confirmed by protein-bound iodine estimations.

In treatment of thyrotoxicosis, dosage is calculated from percentage of I^{131} uptake and the estimated size of the gland. The final judgment is the clinical evaluation of the degree of toxicity. The average oral dose of I^{131} is 7 mc. Pregnancy beyond the 12th week is the only contraindication to radioiodine therapy.

I^{131} has also been used in the evaluation of mediastinal masses. Among 10 cases, I^{131} uptake was increased in the 6 which were found at operation to contain thyroid tissue. Although equivocal results can sometimes be expected, this test is still useful.

I^{131} is used preoperatively in patients undergoing surgery for thyroid carcinoma in order that the degree of uptake can be determined in histologic sections. Therapeutic use should be reserved for the small minority of tumors showing I^{131} uptake In recurrent or metastatic tumors which show I^{131} uptake, 40 to 100 mc of the isotope has been given at four- to six-week intervals. RICHARD E. BUENGER, M.D.
Chicago, Ill.

So-Called "Posterior Mediastinal Goiter." Presentation of a Simplified Surgical Approach. Irving L. Lichtenstein, Marcus Rabwin, and Henry L. Jaffe. New England J. Med. **250:** 875–877, May 20, 1954.

This is a case report of so-called "posterior mediastinal goiter," making a total of 17 to be found in the literature. The patient complained of dysphagia, choking, nausea, and vomiting. At first, this was considered to be psychic. No thyroid could be palpated in the neck. Roentgen examination showed a mass in the right mediastinum, causing the trachea and esophagus to deviate to the left. A barium swallow localized the tumor in the retroesophageal or posterior mediastinum, and repeated radioiodine uptake studies identified the mass as thyroid. This was an important finding, since substernal thyroids receive their blood supply from the neck and are therefore approached from above. Mediastinal tumors are approached through the thorax.

The authors make a point that the trachea, esophagus, and thyroid are enclosed by one fascial plane so that the thyroid does not have to break through such

planes in order to extend behind the esophagus. They recommend the term "substernal retroesophageal goiter" to replace "posterior mediastinal goiter."

Three roentgenograms; 1 drawing.

WILLIAM SNOW, M.D.
Shreveport, La.

Adenoma of the Lingual Thyroid. Report of a Case. Jerry Zaslow, David M. Sklaroff, and Harry Kornfield. J.A.M.A. **155:** 359–360, May 22, 1954.

The authors report a case of adenoma associated with a lingual thyroid. Following removal of the tumor, which presented in the submaxillary triangle of the neck, a radioiodine uptake study was done, and scintigrams demonstrated the presence of the lingual thyroid. Such a study, when lingual thyroid tissue is suspected, obviates the necessity of exploratory surgery.

Two scintigrams. PAUL MASSIK, M.D.
Quincy, Mass.

Cobalt 60 Beam Therapy. A. M. Evans, R. G. Moffat, R. D. Nash, H. F. Batho, and S. A. Mibus. J. Fac. Radiologists **5:** 248–260, April 1954.

This report concerns the Eldorado Cobalt 60 Beam Therapy unit. The floor plan of the installation is shown. The equipment has been described in a previous article (Green and Errington: J. Canad. A. Radiologists **3:** 20, 1952. Abst. in Radiology **60:** 156, 1953), but its construction and operation are reviewed briefly here. Isodose curves for a 10 × 10-cm. field at 80-cm. source-skin distance are compared with those for a 220-kv x-ray beam at 50 cm.

The unit has been used for clinical radiation therapy since October 1952, and many cases are cited. Usually tumor doses of 5,000 r to 6,000 r were delivered in a period of four to six weeks. Only patients in good general condition were treated. Lesions which were suitable for standard radium and x-ray technics were not treated with cobalt.

The authors believe that curative treatment has been better tolerated and that it is possible to give palliative irradiation with less disturbance to the patient and with greater ease in treatment set-up than with 200 or 400-kv x-ray therapy apparatus. They consider the cobalt unit of particular value in the treatment of mouth cancer, carcinoma of the larynx, and localized carcinoma of the esophagus, since it is possible to deliver a higher tumor dose with less risk of bone or cartilage damage and a decreased skin reaction.

Eleven illustrations, including 4 roentgenograms; 1 table. RICHARD A. ELMER, M.D.
Atlanta, Ga.

Radiocobalt in the Treatment of Malignant Tumors of the Bladder. G. Mayor. Schweiz. med. Wchnschr. **84:** 510–512, May 1, 1954. (In French)

Over a three-year period, the author treated 60 cases of malignant tumor of the bladder with local application of radiocobalt by the method of Müller, which consists in filling a latex balloon in the bladder with a radioactive solution. The most suitable radioelement appears to be cobalt, with a half-life of five years, and a mean energy resembling that of radium. The soft radiation is absorbed by the wall of the balloon holding the solution. The optimal distance for therapeutic efficacy is 8 to 12 mm.

In actual practice, a flat papillary tumor or a diffuse malignant recurrent papillomatosis can be irradiated immediately without preliminary local treatment. Exophytic tumors should be resected by endoscopy or through the opened bladder before the application of the isotope. The balloon, with its attached catheter, is introduced from below, filled with a colored solution, and left in place several hours. In this period, it is easy to determine whether the tolerance of the patient is sufficient and whether the balloon is absolutely watertight. If these conditions are met, the colored liquid is replaced with the radiocobalt solution. The duration of the irradiation is from eight to ten days with a balloon containing 60 c.c. of solution, giving a dose of 11,000 to 12,000 r.

Though the contact of the balloon with an often infected bladder mucosa naturally provokes an intense cystitis, it became necessary in only 2 cases to discontinue the treatment, once because of a large hemorrhage obstructing the catheter and once because of violent tenesmus. A serious immediate complication is perforation of the balloon during the treatment. The radioactive liquid diffuses through the bladder and the radiocobalt is rapidly absorbed by the organism, accumulating in the liver and in the bone marrow. This accident occurred in 2 cases, but fortunately it was possible to evacuate the bladder immediately, and treatment was resumed some months later.

The immediate results of treatment are cessation of hematuria in most cases (it persisted intermittently in 11 of the author's patients), disappearance of cystitis under antibiotic therapy, and a slow return of reduced bladder capacity toward normal. None of the cases appears to have been followed for longer than three years, and some less than a year. The results were considered favorable in 37 per cent (cessation of hematuria and no relapse on cystoscopy). Thirty-five per cent are classified as improved. Six of the 21 patients in this group had recurrences, 15 had a resistant cystitis, and 8 showed mucosal alterations which could be interpreted as radionecrosis. The results in the remaining 28 per cent were poor; all the patients had died at the time of this report.

The author concludes that treatment of malignant tumors of the bladder remains a surgical problem, radiocobalt being considered only an adjuvant. Under the best conditions, treatment with radiocobalt is indicated in recurrent malignant papillomatosis and in cases of papillary carcinoma after surgical resection of the tumor. For markedly infiltrative tumors, the treatment with radiocobalt is unfeasible, and surgery with the later application of a very penetrating ray such as from the betatron is preferable.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

A Collimating Device for Cobalt 60 Teletherapy Units. H. E. Johns and J. A. Mackay. J. Fac. Radiologists **5:** 239–247, April 1954.

The large sources used for cobalt therapy introduce penumbra problems if the limiting diaphragm is placed some distance from the skin surface. A distance of 15.0 to 20.0 cm. between the last diaphragm and the skin is necessary to eliminate scattered electrons from the gamma ray beam. If these are present, the surface dose is raised and the skin-sparing effect of cobalt radiation is lost. With 20 cm. distance penumbra problems must be considered. The diameter and specific acitivity of the source must be balanced against each

other, considering the disadvantages of the large source against the economic advantages of the low specific activity source. A source between 2.0 cm. to 1 inch in diameter seems to be a suitable compromise between these considerations. With a properly designed collimator, the penumbra effects with a source 1 inch in diameter are not extensive and distributions of radiation even at the edge of the beam are almost identical with those obtained with a 3-mev machine.

Such a collimator is described in full detail. It is a multiplane unit and is commercially available through Picker X-Ray Corporation. Fields as small as 4 × 4 cm. and as large as 20 × 20 cm. can be used. The physical dimensions of the device are small, making for ease in porting patients and allowing the use of light beam localizers and pin and arc and other types of beam directors.

Eight figures. RICHARD A. ELMER, M.D.
Atlanta, Ga.

Behavior and Action of Colloidal Radioactive Gold in Pleural and Peritoneal Effusions. S. Neukomm, J. Rivier, and P. Lerch. Schweiz. med. Wchnschr. **84:** 512–514, May 1, 1954. (In French)

Periodic abdominal taps of a 49-year-old patient with ovarian carcinoma with diffuse peritoneal spread, before and after the injection of 50 mc of Au^{198}, showed definite morphologic changes in the tumor elements in the fluid, the maximal effect being observed a week after the administration of the isotope. The action of the radiation on the cellular elements was temporary, which could be explained by the small dose, by the extension of the metastasis, or by a combination of the two.

In autohistoradiographs of the sediment of the fluid obtained, it was seen that colloidal gold was fixed exclusively in the macrophages, and not in the tumoral elements. Further, almost all of the granules of radiogold were intracellular four days after its administration, with the exception of some large particles resulting from conglomeration of smaller ones.

The fluid was also submitted to physical study. The mass of cellular elements (histiocytes as well as tumor cells) diminished seven days after injection and then increased rapidly in the following week. This corresponded to the cytologic evolution described above. The non-cellular solids did not vary much, indicating that irradiation, even though it induces a progressive drying of the peritoneal cavity, does not influence the composition of the exudate. The progressive diminution in radioactivity of the effusion is due to two factors: (1) fixation of the radiogold in the serosa *via* the macrophages, this being the more important factor during the first four or five days; (2) simple dilution, this being the more important after that time.

It is believed that radiogold can replace conventional radiotherapy for peritoneal and pleural carcinosis because of the following advantages: the general state of the patient is maintained, the blood picture is not significantly altered, and rapid diminution of the effusion is achieved. This was further confirmed by observation of 4 other clinical cases. The authors' present conception of therapy in these cases calls for an initial dose of 100 mc, followed by 50 to 100 mc ten or fifteen days later. The latter dose depends principally upon the degree of leukopenia evoked by the first dose and the general state of the patient.

Nine figures; 2 tables.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Experiences from 1945 to the Present with the Intraperitoneal and Intrapleural Application of Artificially Radioactive Isotopes (Zn^{65} and Au^{198}) in the Treatment of Ovarian Carcinosis. J. H. Müller. Schweiz. med. Wchnschr. **84:** 509–510, May 1, 1954. (In German)

The author presents the results of his method of introducing a colloidal solution of a radioactive isotope into body cavities as observed in 69 cases of ovarian carcinoma in different stages of extension. Au^{198} was the isotope used, replacing Zn^{65}, which had been formerly employed. The best results were obtained when the treatment was given in combination with the classical methods of therapy—surgery, x-rays, and radium—though isotope therapy alone afforded significant palliation in recurrences after operation or irradiation.

Five-year results are not yet available. The period of follow-up ranges from about six months to four years. Fifteen patients with Stage 1 lesions (radical operative removal possible) received 50 to 225 mc of Au^{198} in addition to operation and postoperative x-ray or radium therapy. All were alive and symptom-free at the time of the report. Ten patients with Stage 2 disease (still operable but with spread to adjacent tissues) were given 80 to 400 mc of the isotope, and of this number 8 were living without symptoms. Of 16 Stage 3 patients (extensive peritoneal and lymphatic metastases; primary tumor still completely or partly resectable), 7 remained symptom-free, a result which is regarded as encouraging for the future development of this mode of therapy. In Stages 4 and 5, with an inoperable primary tumor and massive abdominal and pleural carcinomatosis, only palliative results are to be expected. The Au^{198}, with few exceptions, was effective in controlling the ascites and pleural effusion. Worth-while palliation was considered to have been obtained in 65 per cent of these patients.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

The Survival of Human Erythrocytes Estimated by Means of Cells Tagged with Radioactive Chromium: A Study of the Normal State. D. A. Sutherland, Mary Sue McCall, Margaret T. Groves, and E. E. Muirhead. J. Lab. & Clin. Med. **43:** 717–726, May 1954.

The determination of the average survival time of erythrocytes is of great value for an understanding of the mechanisms responsible in various anemic states. The method of differential agglutination of Ashby (J. Exper. Med. **29:** 267, 1919) has been widely used for this purpose. In an effort to overcome the inherent shortcomings of this procedure, which requires the transfusion of red blood cells into a second individual, with subsequent appraisal of the survival within the recipient, various methods of tagging red blood cells with radioactive isotopes have been developed.

The authors present a study of erythrocyte survival in 5 normal individuals, measured simultaneously by means of differential agglutination and autotransfused red blood cells tagged with Cr^{51}. The red cell survival curves showed extinction at 100 to 120 days by the Ashby technic and at 108 to 120 days by the radiochromium method. The authors therefore conclude that their method yields results comparable to the Ashby differential agglutination technic, in comparison with approximately 50 to 75 per cent of differential agglutination values reported with other Cr^{51} technics.

Five graphs; 1 table. J. F. WEIGEN, M.D.
Palo Alto, Calif.

Pharmacological Studies of Radiogermanium (Ge^{71}). II. Inhalation of Dusts. H. C. Dudley. Arch. Indust. Hyg. & Occup. Med. **8**: 528–530, December 1953.

In earlier studies with germanium and radiogermanium (Arch. Indust. Hyg. & Occup. Med. **6**: 263, 1952. Abst. in Radiology **61**: 155, 1953), it was shown by parenteral injection of suspensions of elemental germanium or germanium oxide that this element is, in general, biologically inert. The effect of inhalation of dusts containing germanium and their fate in the organism has now been investigated by exposing rats to atmospheres containing these materials. The germanium content of the lungs, liver, and kidney was followed for a period of seven days after dusting by counting the 9 kvγ of Ge^{71} (11.4-day half-life). It was found that elemental germanium dust rapidly enters the general circulation, appearing in the liver and kidneys within one hour after completion of the dusting. The rate of clearance from the lungs is exponential, with 52 per cent disappearing within twenty-four hours and only 18 per cent remaining seven days after the exposure. The kidneys and liver excrete the germanium and contain little more than tracer amounts seven days after the dusting. Essentially the same results were obtained with germanium oxide dust.

These findings strengthen earlier conclusions that elemental germanium or the oxide does not constitute an acute industrial hazard. Good housekeeping methods are mandatory, however, owing to possible presence of the hydrides of Ge, As, and Sb.

RADIATION EFFECTS

Roentgen Telangiectasis as a Late Symptom. G. Miescher, J. Plüss, and B. Weder. Strahlentherapie **94**: 223–233, 1954. (In German)

Following acute roentgen erythema the skin reveals alterations in the endothelial cells and fibroblasts, such as swelling and deformity of nuclei, polynuclear cells, etc., still discernible after several years. These cellular changes will be manifest clinically by disturbances of pigmentation, dilatation of the superficial vessels, atrophy, and possibly by sclerosis and ulceration of the skin. The same changes may also occur after contact therapy or after grenz-ray application.

The intensity of the telangiectasis increases with time, from the second to the fifth year, and even to the seventh year after irradiation. The skin of the face is less sensitive to radiation telangiectasis than that of the trunk and extremities.

Ten illustrations; 1 table. LEWIS L. HAAS, M.D.
University of Illinois

Radiation Damage of the Ribs. H. Braun and W. Frik. Strahlentherapie **94**: 234–238, 1954. (In German)

The authors report 4 cases of spontaneous fractures of the ribs following high dosage of roentgen radiation. Three of the patients received irradiation for breast cancer, the fourth for a supposed lung tumor which later proved to be an echinococcus cyst. The additional mechanical stress factor is to be taken into account in the development of these fractures.

Five roentgenograms. LEWIS L. HAAS, M.D.
University of Illinois

Ulcer-Carcinoma Following Single Fluoroscopic Examination Performed Forty Years Earlier. W. Rübe. Strahlentherapie **94**: 239–244, 1954. (In German)

A patient, eighty-six-years old at the time of this report, gave a history of a single fluoroscopic examination in 1912, after an accident. On the day following, a skin reaction had developed on the anterior chest wall, which shortly ulcerated. The ulceration had remained unhealed for forty years in spite of various therapeutic procedures. In 1952 a tumor developed on the margin of the ulcer. Histologic examination showed this to be an anaplastic epidermoid carcinoma arising on the basis of a long standing radiation ulcer. The chronic inflammatory irritation was considered a predisposing factor in the genesis of the ulcer-carcinoma.

Three illustrations. LEWIS L. HAAS, M.D.
University of Illinois

Late Damage from Thorotrast. Myelogenous Leukemia Following Diagnostic Use of Thorotrast. Siegfried Franz Grebe. Strahlentherapie **94**: 311–319, 1954. (In German)

Two cranial arteriographic studies were performed on a patient in 1944. In 1950 he became ill, with symptoms of "flu" with tonsillitis, associated with dyspnea, exhaustion, and cutaneous bleeding. Blood and sternal tests proved the presence of a subacute myeloid leukemia, which terminated fatally after about four months. The right neck showed indurated nodes and radiologically characteristic perivasal Thorotrast shadows in the soft tissues.

Necropsy revealed traces of Thorotrast in various organs, including the liver, spleen, and adrenals, as well as in the bone marrow of femur and spine. The alpha activity per gram of tissue was markedly increased in different parts of the body and in the bone marrow of the ribs, sternum, and femur. It is assumed that the leukemia was due to continuous alpha activity of the Thorotrast deposits on the hemopoietic system.

One table. LEWIS L. HAAS, M.D.
University of Illinois

The Effect of Irradiation on Human Lymphocytes. J. G. Humble, W. H. W. Jayne, R. J. V. Pulvertaft, and C. W. Wilson. J. Fac. Radiologists **5**: 227–238, April 1954.

Observations were made on the effect of irradiation of various parts of the human body on circulating leukocytes and lymphocytes. Five groups of 30 patients each were studied. The sole criteria for selection in each group was that there should be no obvious generalized metastasis and that the tumor at the site of irradiation should be small or have been removed previously.

Group 1 comprised males undergoing postoperative irradiation for seminoma or teratoma testis. These patients received two separate courses of treatment, the first to the lower abdomen and pelvis, followed in six to eight weeks by a further course to the upper abdomen. Group 2 was made up of 30 females undergoing

postoperative x-ray therapy after radical mastectomy, the treatment being given with multiple tangential fields. Group 3 included 28 males and 2 females undergoing radium teletherapy (10-gram source) for carcinoma of the larynx and lower pharynx. Group 4 consisted of 14 males and 16 females treated for a variety of ailments located in the skull. Group 5 consisted of 17 male and 13 female patients with lesions involving the limbs but not the trunk. Most of these patients had primary malignant bone tumor.

The effect of a therapeutic course of irradiation in each group of patients is set forth in graphs. Lymphopenia and leukopenia occurred in all. This effect was most pronounced after irradiation of the abdomen, followed, in order, by the thorax, neck, skull, and limbs. When a second course of irradiation was given in Group 1, a further and even greater fall in leukocytes and lymphocytes occurred. Not all patients, however, had a fall in lymphocytes; in fact, certain patients in each group showed a rise in total lymphocyte count. Inasmuch as these patients received the same treatment as the others, it is evident that individual reaction must play a considerable part in the production of the results.

Authorities discussing the mechanisms by which these changes are produced have failed to provide a uniform and consistent explanation. The writers make the following points: "1. It is unlikely that destruction of circulating lymphocytes can be the cause, for in all the cases studied in this paper the circulating lymphocytes must be heavily irradiated, yet the fall in skull and limb is minimal. 2. In irradiation of the abdomen, chest, and neck, a considerable amount of lymph-node tissue is irradiated directly and destroyed or profoundly modified by the treatment. This is not so in the skull and limbs. 3. Patients who have had two separate areas of the abdomen irradiated show much greater response than do other patients in this series. It is therefore suggested that lymphopenia following irradiation is due to destruction of lymphocyte-forming tissue. This will explain a finding common to this series and also that of Goodfellow (Brit. J. Radiol. **9**: 695, 1936)—a a fall of lymphocytes during the early part of a course of therapy, followed by a later rise even though therapy continues. Here it is postulated that other lymphocyte-forming tissues hypertrophy to take over the function of the destroyed tissue and so maintain the *status quo* in the blood-stream. Both the red bone-marrow and the lymphocyte-forming tissues are much more capable of response to a destructive process such as irradiation than is commonly realized." It follows that "lymphopenia and leukopenia induced by irradiation are not dangerous *per se* to the patient so long as he retains the ability to hypertrophy the remaining undamaged lymphopoietic tissues."

One photomicrograph; 1 diagram; 3 graphs; 2 tables. RICHARD A. ELMER, M.D.
Atlanta, Ga.

Studies on Plasma Proteins, Chlorides and Hematocrit During X-Ray Therapy for Malignant Tumors. G. Pisani and O. Andreoni. Radiol. med. (Milan) **40**: 385–392, April 1954. (In Italian)

The electrophoretic behavior of the plasma proteins, the chloruremia, and the hematocrit readings were determined in 54 patients who received x-ray therapy in repeated 500-r doses. The patients were clinically free from inflammatory complications which might have affected the results. The data thus obtained were analyzed and interpreted on a statistical basis, considering the amount of radiation an "independent variable." According to the author, a moderate decrease of the plasma proteins is observed initially; later, when the total amount of radiation received is higher, hyperproteinemia is noted (due to an increase of alpha and gamma globulins). The hematocrit reading is persistently decreased, and the blood chlorides show a progressive elevation as the treatment continues. No differences were observed between cases of carcinoma and sarcoma.

Ten graphs; 1 table. R. G. OLIVETTI, M.D.
Newington, Conn.

Endocrine Influences on Radiosensitivity (A Review). Friedrich Ellinger. Radiol. clin. **23**: 182–190, May 1954. (In English)

The author summarizes the effects of the several endocrine glands on sensitivity to irradiation, citing numerous clinical and experimental studies from the literature.

The influence of the gonads is shown clinically by increased skin sensitivity in menstruating and pregnant women and decreased sensitivity in oligomenorrhea, and experimentally by decreased reaction of castrated female rats to a standard x-ray dose, with restoration of sensitivity following estrogen administration. It is considered possible that estrogens exert their effect through the spleen, which is under the influence of the adrenal cortex, the latter being of great importance in determining the sensitivity of the body to total irradiation. Testosterone injections enhance the lethal effects of total-body irradiation in mice. This effect is related to the influence of the hormone on metabolism and its effect on lymphatic tissues.

Adrenalectomy increases the sensitivity of the animal to total-body irradiation, an effect which is reversed by administration of whole extract of the adrenal cortex or of desoxycorticosterone acetate. This hormone hastens the recovery of the bone marrow from irradiation, but only if the malpighian bodies have not been completely eliminated. Hence the failure of this hormone to protect against absolute lethal doses of x-rays given as total-body irradiation. Cortisone makes mice more susceptible to total-body radiation and also accentuates the mortality from bacterial and viral infections in irradiated animals. This effect is related to the action of cortisone on lymphatic tissues.

Hypophysectomy makes the animal more susceptible to total-body irradiation, probably because of the effect of this operation upon the adrenal cortex.

Experimentally, thyroidectomy reduces skin radiosensitivity. Conversely, the skin of thyrotoxic patients is unusually radiosensitive, and the injection of thyroxin makes mice more susceptible to total-body irradiation. The effects of the thyroid hormone are related to its metabolism-increasing property and to its effects on capillary circulation and activity of lymphatic tissue.

It is emphasized that the functional status of the organism at any given time is to be considered in radiosensitivity studies. CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Fluctuations of Breath Radon in Subjects Seated at Rest. E. J. Martin and J. K. W. Ferguson. Arch. Indust. Hyg. & Occup. Med. **8**: 574–581, December 1953.

A method is described for determining the actual

amount of radon exhaled during short periods of time. Since it has been customary to take samples for analyses of radon from seated subjects, the authors studied the natural variation of respiratory minute volume (RVM) in this posture and its effects on the radon content of exhaled air expressed as curies per liter (CL) and on the rate of radon elimination in curies per minute (CM).

Large doses of sodium bicarbonate or ammonium chloride were found to have no perceptible effect on radon elimination in curies per liter or curies per minute.

Heavy meals increased radon elimination in curies per minute in 2 out of 3 persons and the elimination in curies per liter in 1 of these 2. The effect of feeding was not very great and not consistent.

Repeated observations were made on 4 subjects over periods of two to five hours under conditions of minimum exertion and low intake of nourishment. In 3 of the 4 subjects, the coefficients of variation of curies per liter and curies per minute were significantly higher than instrumental errors and were about equal. In the same 3 subjects, large variations occurred in respiratory minute volume. Under the conditions of these experiments, no simple relationships between respiratory minute volume and curies per liter or per minute could be identified. Other physiological factors influencing radon output are discussed.

With the subjects seated at rest, reproducibility was poor in 3 out of 4. Little or no improvement was obtained from measuring curies per minute rather than per liter. If the purpose of the measurement is only to follow changes in one subject, measurements of radon elimination in curies per liter alone are adequate. If the purpose is to estimate the radium content of the body, the elimination of radon in curies per minute must be measured.

Two figures.

RADIOBIOLOGY

How Biological Effectiveness Varies with X-Ray Energy. Walter S. Moos. Nucleonics **12**: 46–49, May 1954.

This report presents evidence for a dependence of biological effectiveness of x-rays on wave length, based on irradiation of bacteria. X-rays of 4-kv, 39-kv, 186-kv and 2-mev peak energy were used to irradiate *E. coli* and *Pseudomonas aeruginosa* bacterial strains. For equivalent doses the biological effect decreased with increasing energy above 7-kv peak. In the dosimetry of such experiments it is necessary to consider the transition effect in the surface of the medium, which depends on the range and energy of the secondary electrons. The dependence of the absorption of the incident x-rays on energy must also be taken into account. After these factors are taken into consideration, the variation of specific ionization with x-ray energy remains as the physical parameter with which the change in biological effectiveness may be correlated.

Four figures; 2 tables.

JOHN S. LAUGHLIN, PH.D.
Memorial Center, New York

Investigations of Biological Protection against Radiation. I. Communication. The Influence of Desoxycorticosterone and of Adrenal Extracts on the Effects of a Lethal X-ray Exposure. H. Langendorff, R. Koch, and H. Sauer. Strahlentherapie **93**: 37–43, 1954. (In German)

The authors' experiments with mice confirm Ellinger's findings that desoxycorticosterone and adrenal extracts reduce the mortality after a single exposure of 500 r.

One graph. ULRICH K. HENSCHKE, M.D.
Ohio State University

Influence of X-Irradiation Upon Body Weight and Food Consumption of the Rat. Douglas E. Smith and Ella B. Tyree. Am. J. Physiol. **177**: 251–260, May 1954.

Body weight and consumption of food were measured daily following single total-body and single partial-body exposures of the rat to irradiation.

Total-body exposure resulted in anorexia and weight loss which fell into distinct patterns in relation to x-ray dosage. Exposures of 25 to 500 r (sublethal doses) induced anorexia and weight loss from which recovery began in two to four days. Dosages of 800 r (80 per cent lethal) were followed by a more profound anorexia and weight loss which lasted until death in rats succumbing within seven days after exposure but only for four to five days in those that survived for longer periods. Recovery from anorexia after 800 r was permanent for twenty-eight-day survivors but only temporary for non-survivors, since these animals showed a sharp fall in food consumption and body weight beginning on the tenth to twelfth day following exposure and lasting until death. Dosage of 1,000 to 10,000 r elicited severe anorexia and weight loss from which there was no recovery.

The magnitude and duration of the anorexia and weight loss immediately following exposure were dependent upon radiation dosage. The threshold for these changes was as low as 25 r. Their degree and duration increased with ascending radiation dosages. Upon cessation of anorexia, the time necessary to regain the initial body weight was a function of dose. Loss in body weight following irradiation paralleled the decrease in food intake, and the degree of weight loss was dependent upon the magnitude of the anorexia. Dosages of less than 1,000 r elicited a pattern of weight loss similar to that seen in the starving animal, *i.e.*, a high rate of weight loss on the first two post-irradiation days followed by a progressively decreasing loss on succeeding days. After dosages of 1,000 r or more, however, there was a high rate of weight loss on the first day, a marked decrease on the second day, a return to the initial high rate on the third day, and maintenance of this rate until death.

Similar changes occurred following exposure of practically any region of the body. The degree and duration of the effects depended upon the portion of the body irradiated.

The possible relationship to the results obtained in this investigation and the known histologic and functional alterations in the gastrointestinal tract are discussed.

One graph; 9 tables.

Effect of X-Irradiation on Performance of Volitional Activity by the Adult Male Rat. D. C. Jones, D. J. Kimeldorf, D. O. Rubadeau, G. K. Osborn, and T. J. Castanera. Am. J. Physiol. **177**: 243–250, May 1954.

The effect of single acute doses of x-rays, ranging from

200 to 1,000 r, upon the daily volitional activity level of adult male rats was determined in a study of malaise and physical performance. At all doses studied there was an abrupt significant depression of activity. This initial decrease in activity was immediately followed by a period of recovery (increasing activity). At 200 and 300 r, recovery was complete within five days of irradiation, and there was no further discernible effect of irradiation at this level upon volitional activity. With doses of 400 r or greater, there was a second significant decrease in activity which reached a maximum value during the third week after irradiation. The time necessary for survivors to complete recovery from this second decrease in activity appeared to be proportional to the x-ray dose. When animals died within the first nine days after irradiation, their activity decreased continuously from the time of irradiation until death. With decedents which survived longer than nine days, the initial decrease in activity was followed by some recovery and then by a second decrease in activity which continued until death.

Three graphs; 4 tables.

Therapeutic Effect of Rat Bone Marrow Injection in Rats Exposed to Lethal Whole Body X-Radiation. M. C. Fishler, L. J. Cole, V. P. Bond, and W. L. Milne. Am. J. Physiol. **177**: 236–242, May 1954.

The authors studied the effect of parenteral administration of normal homologous rat bone marrow suspensions on morbidity and lethality in irradiated rats. Animals of both sexes, from six to nineteen weeks of age and weighing 200–300 gm., were used in the investigation. The radiation factors were 250 kvp, 15 ma, 0.5 mm. Cu plus 1.0 mm. Al filtration, 40 in. skin-to-target distance, dose rate approximately 25 r per minute. One milliliter of bone marrow suspension in phosphate buffer was injected by tail vein into the irradiated rats, usually within two to four hours after the x-ray exposure. The control irradiated rats each received 1.0 ml. phosphate buffer intravenously.

It was found that a single injection of rat bone marrow after whole-body exposure in the lethal and supralethal range (675–770 r) elicited a modification in response which was reflected in decreased mortality and enhanced body weight recovery as compared with control rats. After injection of 50 to 100 mg. of marrow into rats exposed to 700 or 725 r, 70 per cent survived the 30-day observation period, whereas none of the controls survived. At higher radiation dosage levels (750 and 770 r), the administration of larger amounts of bone marrow, *e.g.*, 200 mg./rat, was required for protection. Following exposure to 800 r, the injection of bone marrow had no influence on survival or on mean survival time even with a dose of 400 mg. marrow/rat. The mean survival time of these animals was approximately six days.

Forced feeding of Aureomycin plus Sulfasuxidine to rats for a period of five days following exposure to 725 r had no effect on survival, nor did this treatment enhance the protective effect of bone marrow.

The comparative protective activity of mouse and rat bone marrow is discussed. It is proposed that the predominance of the "intestinal syndrome" (characterized by early deaths) in total-body irradiated rats exposed to dose levels of the order of 800 r, and higher, may constitute the limiting factor for bone-marrow therapy in this species.

Five graphs; 1 table.

Mortality Due to X-Ray in Splenectomized Mice. Antolin Raventos, with the technical assistance of Martin L. Davison. Am. J. Physiol. **177**: 261–263, May 1954.

Infant and pubertal mice were subjected to a mid-lethal dose (550 r) of whole-body irradiation after splenectomy. Post-irradiation mortality was slightly higher in the splenectomized mice than in unoperated or sham-operated litter mates, but the difference is not considered great enough to warrant the supposition that any specific factor in the spleen promotes recovery after whole-body irradiation when the spleen is not specially protected. No difference in the influence of splenectomy upon radiosensitivity was found between the two age groups.

One illustration; 1 table.

The Effects of Testosterone Propionate and Testosterone Cyclopentylpropionate Upon Morbidity and Mortality in Mice Following Lethal Total-Body Irradiation. Mitchell W. Spellman, James C. Carlson, and C. Walton Lillehei. Cancer **7**: 617–621, May 1954.

Inbred male mice, six weeks of age, were given total-body irradiation (550 r in air) with the following factors: 220 kvp, 15 ma, 70 cm. distance, 20 × 22-cm. port, 0.5 mm. Cu and 1 mm. Al added filtration. Testosterone propionate (0.1 mg. in cottonseed oil subcutaneously every day for thirty post-irradiation days) provided no protection against this lethal total-body irradiation. Testosterone cyclopentylpropionate (1 mg. subcutaneously every fourteen days for thirty post-irradiation days), on the other hand, provided significant protection. This protection was further enhanced by pretreatment with 1 mg. of the drug ten to fourteen days prior to irradiation (30-day mortality of 24 per cent *vs.* the irradiated control mortality of 70 per cent).

Four graphs.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

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